AMETEK®
DREXELBROOK

Leader in
Level Measurement

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Installation and Operating Instructions

DR7000 Series
Radar Level Instrument
for
Two-Wire Control Systems

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Radar Level Instrument
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An ISO 9001 Certified Company

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Quick Start

DR7000 Radar Level Measurement System

Measurement of distance, level and volume of liquids, slurries and solids

- Easy installation
- Wizard driven
- Service and maintenance-free

General

For in-depth information please consult the hand-book, data sheet, special manuals and certificates supplied.

Installation, assembly, commissioning and servicing must only be undertaken by trained personnel. Maintenance which is considered relevant to safety in the sense of explosion protection must only be carried out by the manufacturer, his agents or under the supervision of experts.

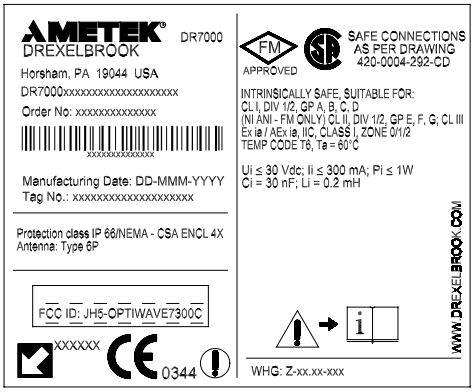
For use in hazardous areas, special codes and regulations are applicable, which are supplied in a separate document that describes all hazardous area relevant information.

Responsibility as to suitability and intended use of this device rests solely with the user. The supplier does not accept any liability resulting from misuse by the customer. Improper installation and operation may lead to loss of warranty. In addition, the “General conditions of sale”, found on the back of the invoice and forming the basis of the purchasing contract, are applicable.

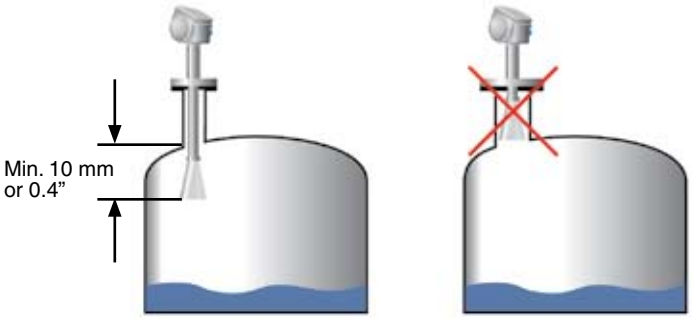
If you need to return the device to the manufacturer or supplier, please complete the form in Section 9.0 and attach to the device. Drexelbrook regrets that it cannot repair or check your device unless accompanied by this completed form.

Items supplied

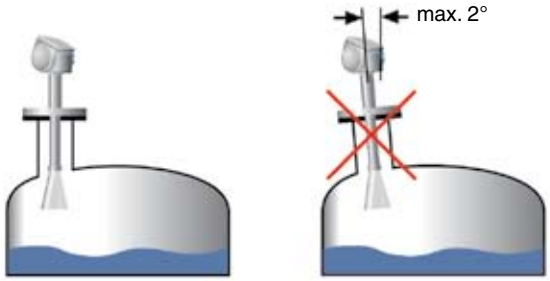
Visual check

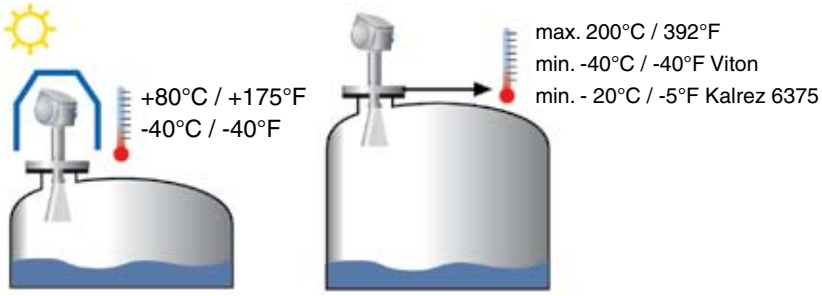


Handling and installation instructions



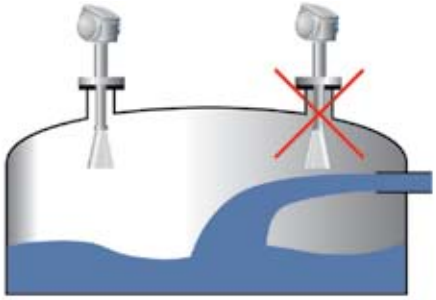
Antenna must protrude from nozzle base.





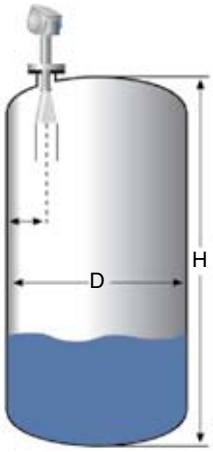
Handling and installation instructions

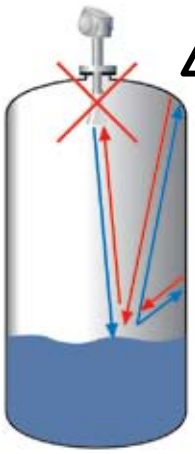
Install away from entry pipe.



ANSI 1 1/2, 2"
DN 40 / 50 or 1 1/2"
threaded:
> 1/7 H, but max. 1/3 D

ANSI 3"
DN 80:
> 1/10 H, but max. 1/3 D

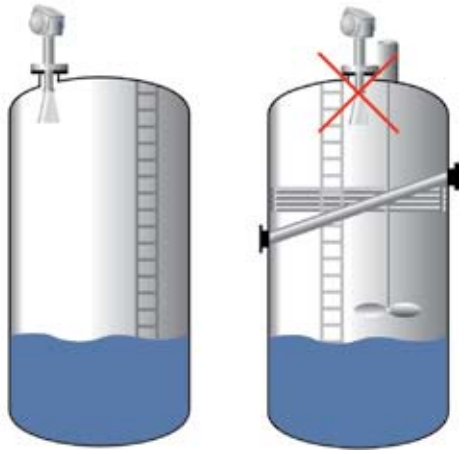




Mount off-center to avoid multiple reflections.

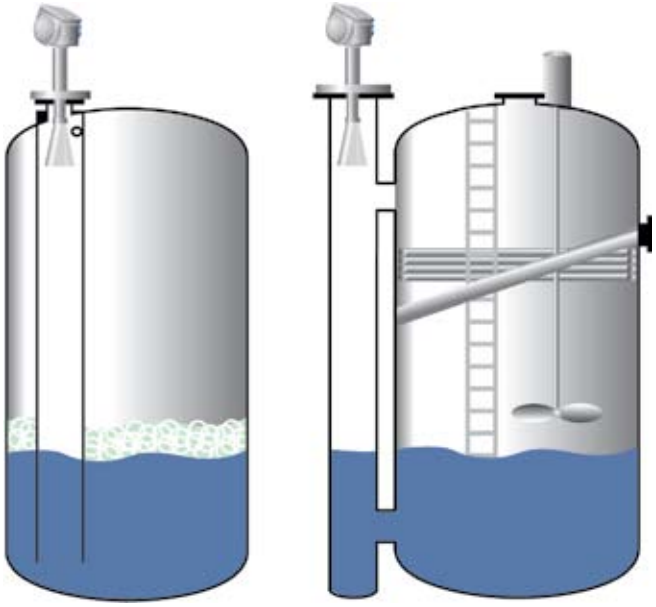
Special considerations

Avoid too many objects near to the radar beam in tank. Will Cause Stray reflections!



Stilling wells and bypass chambers

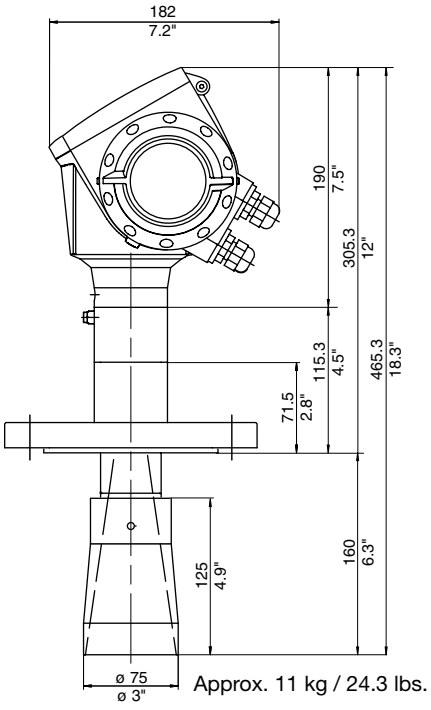
Foam: use stilling well



Too many objects in tank: use bypass chamber

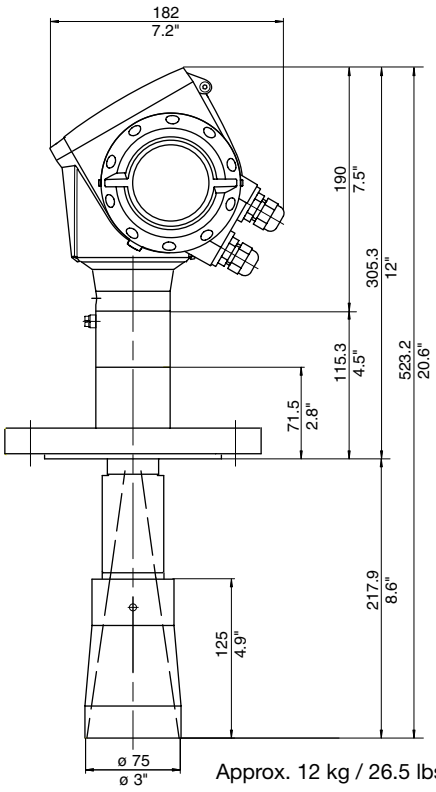
Dimensions and Weights

Flange Antenna (DN 80)

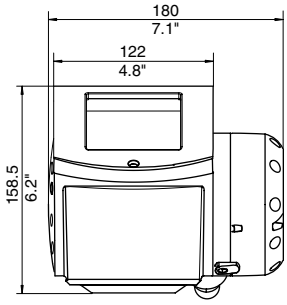


Approx. 11 kg / 24.3 lbs.

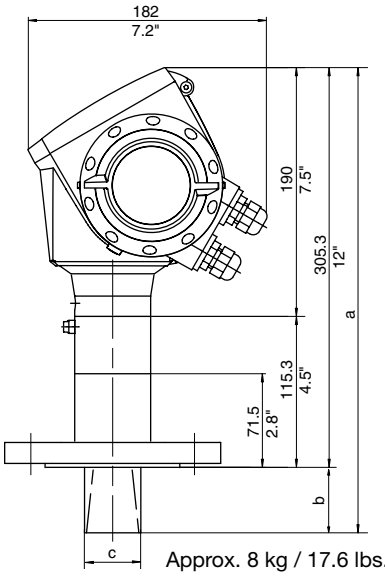
DN 80 with Antenna Extension



Approx. 12 kg / 26.5 lbs.

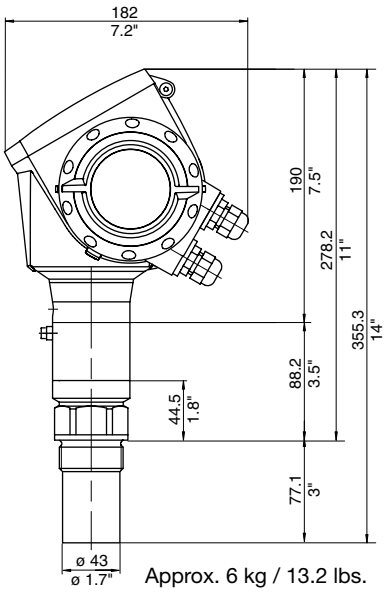


Flange Antenna (DN 40 / 50)



Approx. 8 kg / 17.6 lbs.

Threaded Antenna



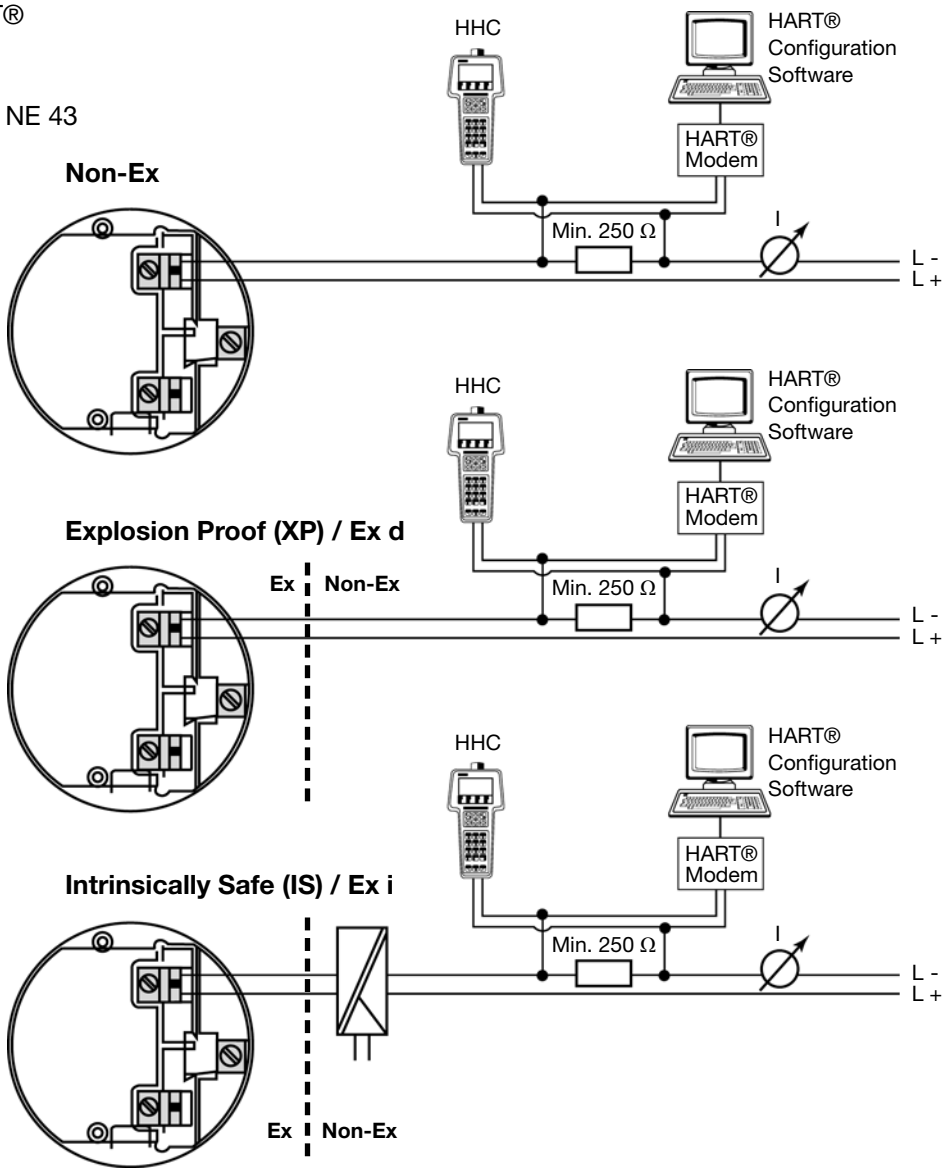
Approx. 6 kg / 13.2 lbs.

Antenna Type	c mm / Inch	b mm / Inch	a mm / Inch
Antenna DN40	39 / 1.5	39 / 1.5	344 / 13.5
Antenna DN50	43 / 1.7	50 / 2	355 / 14

Terminal Compartment and Terminals

Connection procedure
- Unscrew terminal compartment cover.
- Wire up using standard procedures.
- Observe correct polarity!
- Apply grease to thread of cover regularly.

Output 1
4 - 20 mA HART®
or
3.8 - 20.5 mA
Acc. to NAMUR NE 43



Note: Other options to connect the HHC and modem to the HART ® loop are available.

Technical data extract

Input

Function	K-band FMCW radar
Parameter	Level, distance, volume and reflectivity
Min. Tank Height	0.5 m / 1.5 ft
Max. Range	40 m / 131 ft
Dead Zone	Antenna length + 0.1 m 4” + antenna length

Output

Output signal	4 - 20 mA HART® or 3.8 - 20.5 mA acc. to NAMUR NE 43
Accuracy	0.05% (rel. 20 mA; 20°C / 68°F)
Resolution	±2 µA
Temperature Drift	Typically 50 ppm/K
Error Signal	High: 22 mA; Low: 3.6 mA acc. to NAMUR NE 43
Max. Load	350 ohm

Measuring Accuracy - Reference conditions acc. to IEC770

Temperature	+20°C ±5°C / +68°F ±9°F
Pressure	1013 mbar abs. ±20 mbar 14.69 psig ±0.29 psig
Relative Humidity	60% ±15%
Resolution	1 mm / 0.04 “
Accuracy	±3 mm / ±0.12”
Beam Angle:	DN 40 / ANSI 1 1/2” 20° DN 50 / ANSI 2” 15° DN 80 / ANSI 3” 10°

Application Conditions

Ambient Temp.	-40…+80°C / -40…+175°F; EEx i: -40…+60°C / -40…+140°F
Storage Temp.	-40…+85°C / -40…+185°F
Flange Temp.	-40…+200°C / -40…+392°F (Ex: refer to relevant device spec.)
Shock Resistance	100°C/min

Process Conditions

Operating Pressure	1…40 bar / -14.5…580 psig; subject to process connection and temp.
Dielectric Constant	±1.5
Vibration Resistance	IEC 68-2-6 and prEN 50178 (10...57Hz: 0.075 mm / 57...150 Hz: 1 g)
Protection Category	IP 66/67 equiv. to NEMA 6-6X

Mechanical Data

Housing	Aluminium
Wetted Parts	Stainless steel (1.4404 / 316L); Hastelloy C-22 (2.4602)
Process Fitting	Stainless steel (1.4404 / 316L); Hastelloy C-22 (2.4602)
Gaskets	Viton (-40…+150°C / -40…+300°F); Kalrez 6375 (-20…+150°C / -5 …+300°F)

Process Connection

Thread	G 1 1/2; NPT 1 1/2
Flange	DN 40…DN 150 (PN 40 / PN 16); 1 1/2”…8” (150 lb / 300 lb); 10 K (40…100A)

Electrical Connection - 2-Wire Power Supply

Terminals Output 1	Non-Ex/ EEx i 24 V DC (14 … 30 V DC) EEx d 24 V DC (20 … 36 V DC)
Cable Entry Terminals	M20x1.5; 1/2 NPT; G 1/2 0.5…1.5 mm²

Human machine interface

Display	9 lines, 160x160 pixels in 8-step greyscale with 4-button keypad
Operating Languages	English, German, French, Italian, Spanish, Portugese, Japanese, Chinese (Mandarin), Russian

Approvals

ATEX	ATEX II G D EEx ia IIC T3...T6 ATEX II 1/2 G D EEx d [ia] IIC T6...T3
FM	IS class I Div. 1 Gr. A...G; XP class I Div. 1 Gr. A…G
CSA	CL. 1, Zone 1 Ex d [ia], IIC CL. 1, Zone 0 Ex d ia, IIC

Human interface

Program mode:
Saves data or confirms parameter.

Program mode:
ESC-function returns to previous menu. If top menu reached, returns to normal mode.
Any parameter value entered is not stored.

Startup procedure

Mount and wire the device; then turn the power supply on.
The device performs a self-test and is ready for use.

If false parameter value is inputted (e.g. outside limits) an error message / icon occurs, and after 10 seconds the screen switches to HELP function. Press “ESC” to return to function.

Human interface

Hot keys

Mode	Hot key activated when:	Action
Normal	Hold > 3 seconds	Enters program mode
Program		Saves current function used as quick link
Normal	Hold ▼ 3 seconds	Active screen stored as default screen
All modes	Hold ▲ 3 seconds	HMI will reset to default language
Program	Hold > + ▲ 3 seconds	Returns to normal mode (last screen displayed)

Startup procedure

The setup Wizard automatically displays steps on-screen.

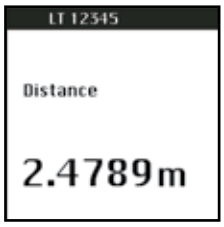
If error persists, download log file using PACTware and send to e-mail address given on back page.

Setup procedure

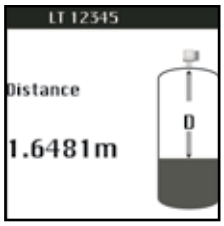
(Connect power supply) - Starting up... Please wait... Booting up... (Start up time 40 sec)

Normal Mode

Text Screen



Text + Picture



Text + Bar Graph

Hold > 3 Sec.

Program Mode

Main Menu

- Quick Setup
- Test
- Advanced setup
- Service

Quick Setup

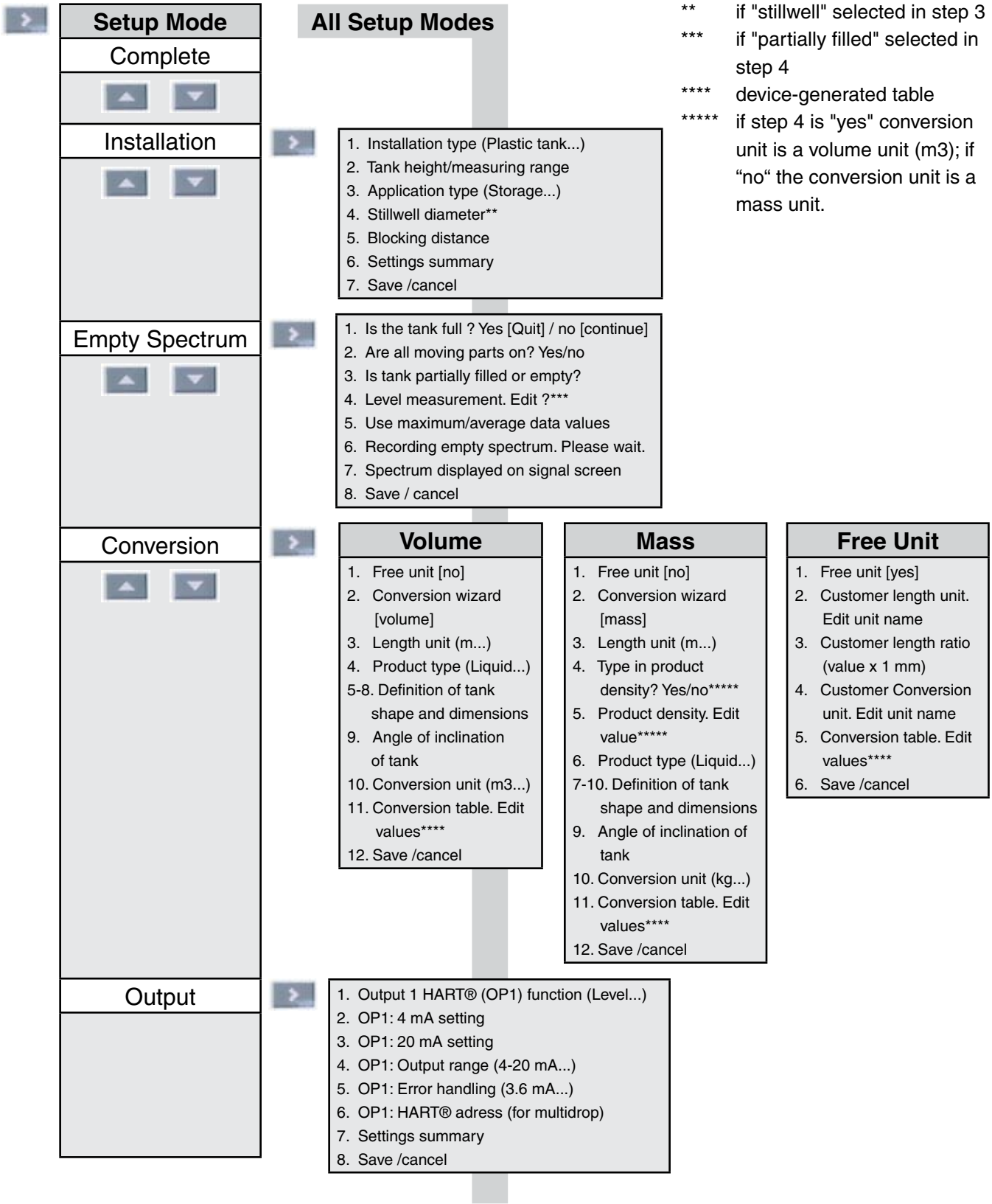
- Setup Mode
- Quick link #1*
- Quick link #2*
- Quick link #3*
- Quick link #4*
- Quick link #5*

*For direct access to and modification of a default or user-defined menu item. Assign any menu item in the **Advanced setup menu** to the quick link list (this overwrites default items) by pressing **>** for 3 seconds.This saves time finding an item and avoids using a setup mode.

Setup Mode

Continued on Next Page...

Setup procedure (Continued from previous page)


Setup Mode
All Setup Modes
Complete
Installation
1. Installation type (Plastic tank...)
2. Tank height/measuring range
3. Application type (Storage...)
4. Stillwell diameter**
5. Blocking distance
6. Settings summary
7. Save /cancel
Empty Spectrum
1. Is the tank full ? Yes [Quit] / no [continue]
2. Are all moving parts on? Yes/no
3. Is tank partially filled or empty?
4. Level measurement. Edit ?***
5. Use maximum/average data values
6. Recording empty spectrum. Please wait.
7. Spectrum displayed on signal screen
8. Save / cancel
Conversion
Volume
1. Free unit [no]
2. Conversion wizard [volume]
3. Length unit (m...)
4. Product type (Liquid...)
5-8. Definition of tank shape and dimensions
9. Angle of inclination of tank
10. Conversion unit (m3...)
11. Conversion table. Edit values****
12. Save /cancel
Mass
1. Free unit [no]
2. Conversion wizard [mass]
3. Length unit (m...)
4. Type in product density? Yes/no*****
5. Product density. Edit value*****
6. Product type (Liquid...)
7-10. Definition of tank shape and dimensions
9. Angle of inclination of tank
10. Conversion unit (kg...)
11. Conversion table. Edit values****
12. Save /cancel
Free Unit
1. Free unit [yes]
2. Customer length unit. Edit unit name
3. Customer length ratio (value x 1 mm)
4. Customer Conversion unit. Edit unit name
5. Conversion table. Edit values****
6. Save /cancel
Output
1. Output 1 HART® (OP1) function (Level...)
2. OP1: 4 mA setting
3. OP1: 20 mA setting
4. OP1: Output range (4-20 mA...)
5. OP1: Error handling (3.6 mA...)
6. OP1: HART® adress (for multidrop)
7. Settings summary
8. Save /cancel

** if "stillwell" selected in step 3

*** if "partially filled" selected in step 4

**** device-generated table

***** if step 4 is "yes" conversion unit is a volume unit (m3); if “no“ the conversion unit is a mass unit.

Full details see handbook

0.0 Introduction

The DR7000 level gauge is designed solely for measuring the distance, level, volume and reflection of liquid, paste, slurry, and solid materials. The DR7000 level gauge does not form part of an overfill protection system. Special codes and regulations apply to its use in hazardous areas. Responsibility as to suitability and intended use of these level gauges rests solely with the user. Improper installation and operation of our level gauges may lead to loss of warranty.

The DR7000 is a new-generation level meter with a wizard-driven setup, fully-potted electronic subassemblies, an online help functions.

It is provided with a pictorial quick setup. You will not normally need this Handbook to install, set up and operate the device.

All menu items have an on-screen help function that is activated 15 seconds after the last input.

In the unlikely event of a failure, error icons appear on-screen. Clicking on the error icon in the PACTware device tool manager software or by looking in the error record menu item in program mode using the device screen wizard displays an error description, which normally is sufficient to rectify the problem. Only in severe cases will you need to consult the error records.

General Advice on Safety

- Visually inspect the equipment before installation to check that it has not been damaged in transit.
- Follow all instructions carefully to make sure that you install the device correctly
- Observe special conditions for installations requiring approved equipment
- Check that the flange, gasket and antenna materials are compatible with the product in the tank.
- Check that that the information on the device nameplate conforms to the on-site data
- Wire according to local rules and regulations
- Remove the device from the installation before servicing, except for replacement of the housing as described in section 6.2.

0.1 Legal Matters

Authorised Personnel

Installation, assembly, commissioning and servicing must only be undertaken by Drexelbrook-trained personnel.
Maintenance which is considered relevant to safety in the sense of explosion protection must only be carried out by the manufacturer, his agents or under the supervision of experts.

Liability

Responsibility as to suitability and intended use of these devices rests solely with the user. Improper installation and operation may lead to loss of warranty. In addition, Drexelbrook's General Conditions of Sale and Delivery, found on the back of the invoice and forming the basis of the purchasing contract, are applicable.

Special codes and regulations apply to its use in hazardous areas.

General Limitation on Liability

Unless otherwise expressly set forth in the Standard Terms and Conditions of Sale and Delivery, the Seller is only liable for damages, whatever their legal basis is, in case they are based on wilful action or gross negligence.
This limitation on liability does not apply in the event the Buyer raises claims relating to personal injury or damages to property according to the product liability law based on a defect of the delivered goods.
Any advice given by the Seller, in particular regarding the application of the delivered goods, shall only commit the Seller if given or confirmed in writing.

Returning the Device

If you need to return the level gauge to the manufacturer or supplier, please read to the instructions and complete the form in Section 9.0.

0.2 Warranty

1. The Buyer shall examine the goods immediately after receipt with reasonable care; defects discovered shall be reported to the Seller within a preclusive period of 2 weeks in writing. Not recognizable defects shall be reported in writing to the Seller within 2 weeks after discovery.

2. In case of a justified immediate notification of defects, a warranty will be granted either by repairing the goods (rectification of defects) or replacement of default parts (subsequent delivery). Instead the Seller shall also be entitled to compensate the decrease in value when obeying the interest of the Buyer appropriately.

3. In case the Seller does not comply to rectify defects or to replace defective parts or the rectification or replacement fail, the Buyer shall be entitled to reduce the remuneration or, at his option, to rescind the contract.

4. As regards spare parts, parts being subject to wear and tear or parts being designated to become a part of or to be converted into other products, the Buyer is committed to examine such parts and give notification of defects within the time period set forth in paragraph 1. With regard to defects which could have been noticed before installation or conversion, any warranty claims are excluded after installation and conversion.

5. In case the Buyer requests examination of the delivered goods by the Seller and alleges a defect for which the Seller would be responsible according to paragraph 2 above, the Buyer shall be committed to bear the associated costs in case it turns out that the delivered goods are free from such defect.

6. Other or further claims of the Buyer based on defects including claims for damages, also with respect to consequential damages, are excluded. In case of non-compliance with a guarantee, which has to be designated and confirmed in the order confirmation as guarantee, claims for damages can only be enforced, if it was intended that the guarantee given to the Buyer should apply precisely to damage of the kind that has occurred.

7. The Seller's liability is expired, if the goods delivered have been dismantled by a third party or altered by the incorporation of parts produced elsewhere and the cause of the damages is connected with such alterations. The Seller's liability is also expired, if the Buyer does not duly observe the Seller's instruction for handling the goods (installation & operation instructions).

8. Seller warrants that for a period of 12 months from start-up or 18 months after passing the risk, whichever comes first, under normal use and service its products will function in accord with the current product specifications if installed and operated in accordance with the accompanying installation manuals; but the Buyer is solely responsible for determining the suitability of the products for the Buyer's use.

0.3 Standards and Approvals

Standards

All versions of the device conform to European Union electromagnetic compatibility (89/336/CEE) and low voltage equipment (73/23/CE) Directives and Standards that allow use of the CE mark.

These and other relevant standards are listed in Standards.

Approvals

Versions equipped with the necessary options are suitable for use in hazardous areas meeting either European or American-Canadian approval requirements.

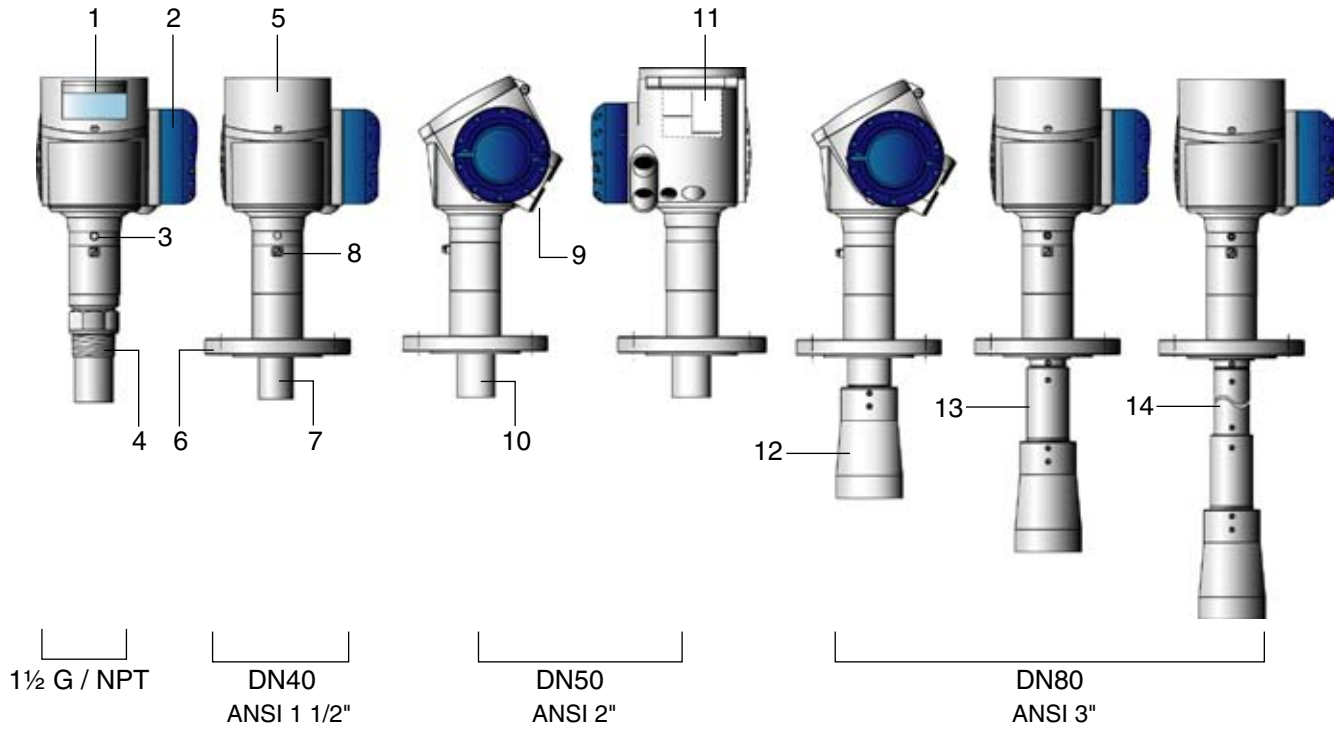
These are:

- ATEX (European)
- Joint FM and CSA (American-Canadian)

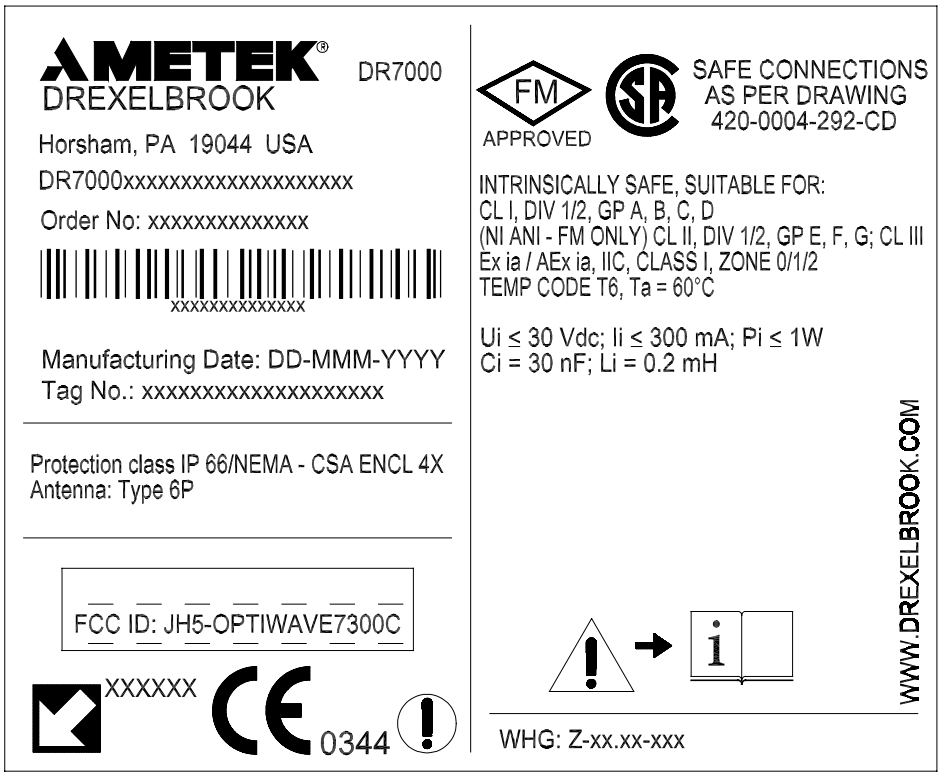
0.4 Principal Meter Components and Options

Non-Ex and Ex versions

1. Cover with display (option)
2. Wiring compartment cover
3. Socket head set locking screw for either rotating or removing the housing
4. Threaded process connection (NPT, G)
5. Cover without display (standard)
6. Flange
7. Horn antenna DN 40
8. Equipotenial bonding system connection (Ex)
9. Cable entry (M20, NPT½ or G½ adaptor supplied without cable gland)
10. Horn antenna DN 50
11. Nameplate
12. Horn antenna DN 80 (standard length)
13. Primary DN 80 antenna extension (optional)
14. Horn antenna DN 80 (specific to primary antenna extension)
15. Supplementary antenna extension module
    (length 105 mm or 4.1"; max. 10 modules)



0.5 Nameplates



0.6 Items Supplied

- Signal converter with process connection connected to horn antenna, material and size as per order.
- Optional: sunshade (fastening material supplied)
- Quick-start guide
- Ex instructions (for Ex version only)
- Calibration certificates with print-out of factory settings (where applicable)

0.6.1 Items not supplied

- Nuts, bolts, gaskets and seals for fitting to existing nozzles, etc.
- Cabling and non-standard connections / cable glands
- Service manual since - apart from exchanging entire subassemblies - this device can only be factory serviced.

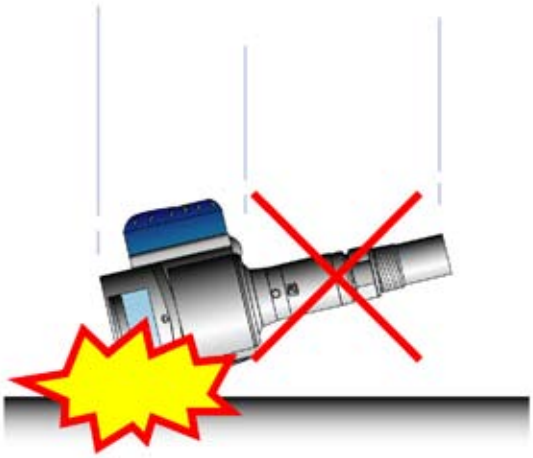
0.7 Storage and Handling

Handling

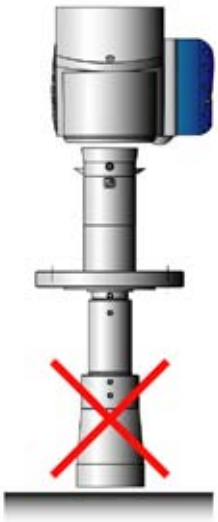
Mount DR7000 radar level meters on suitable process connections on a tank or sump.
The device weighs between 8 kg/18 lb and 10 kg/22 lb.

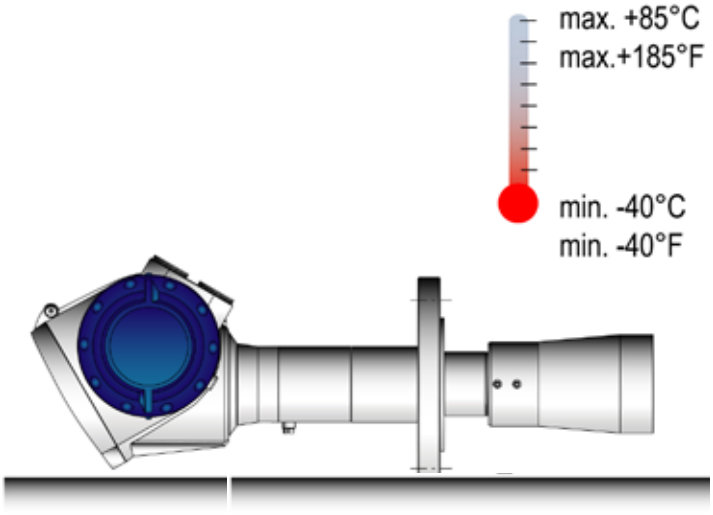
Lift the meter by the flange using two people to avoid damaging the base of antenna.
Support the housing and antenna while installing the device.

Avoid Hard blows, Impacts and Jolts



Storage





1.0 Location

1.1 All Applications

General Notes

This section covers positioning the process connection and installing the device.

Mount the DR7000 gauge on a suitable process connection on a tank or sump.

Check the following:

- Nozzle position in relation to the tank walls, product entry points and other objects inside the tanks.
  This free space around the probe will depend on the antenna used - refer to later on in this section

NOTICE

- Installation according to radio approval requirements (section 1.3.1)
- Installation adapted to the application

For further information on applications, refer to:

Section 1.2.2 Location - Liquid Applications
Section 1.2.3 Location - Solid Applications
Section 1.3 Typical - Installations

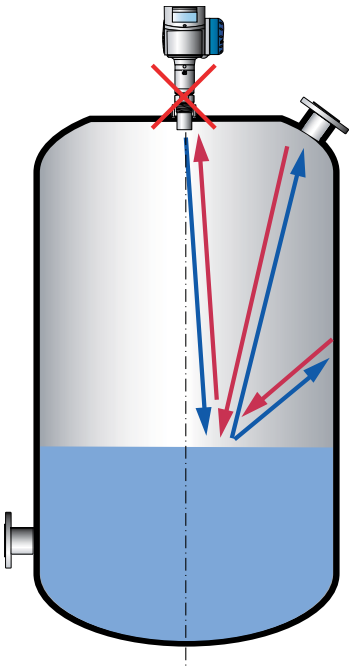
Hazardous areas

Refer to Appendix A.

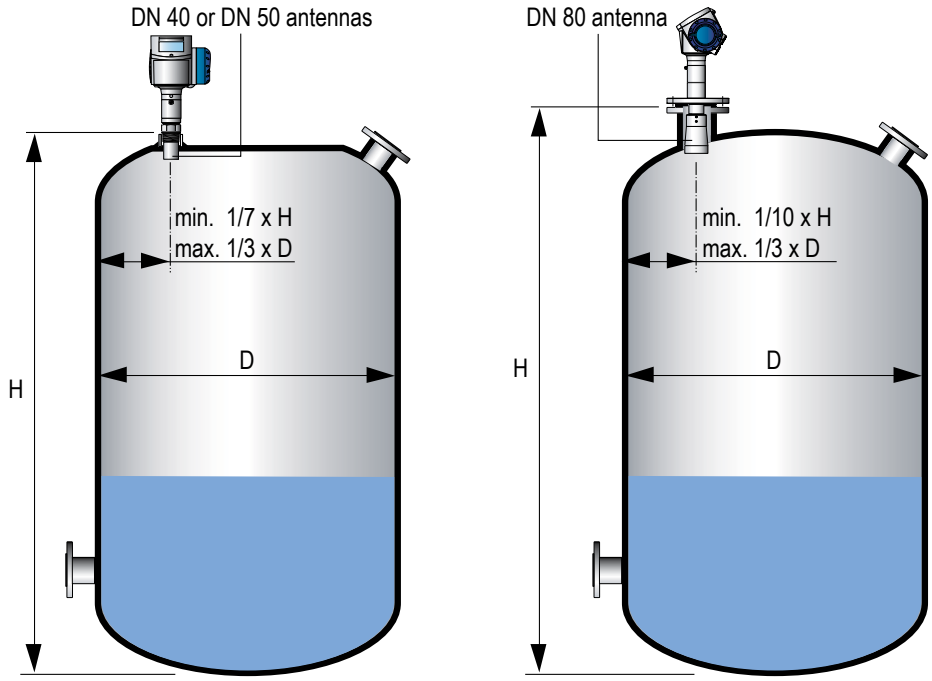
Process connection

Distance of fitting from tank wall

Do not install fitting on tank centreline. This causes multiple reflections and measurement errors when the device is in operation.



The Ideal Distance from the Tank Wall Depends on Antenna Size.

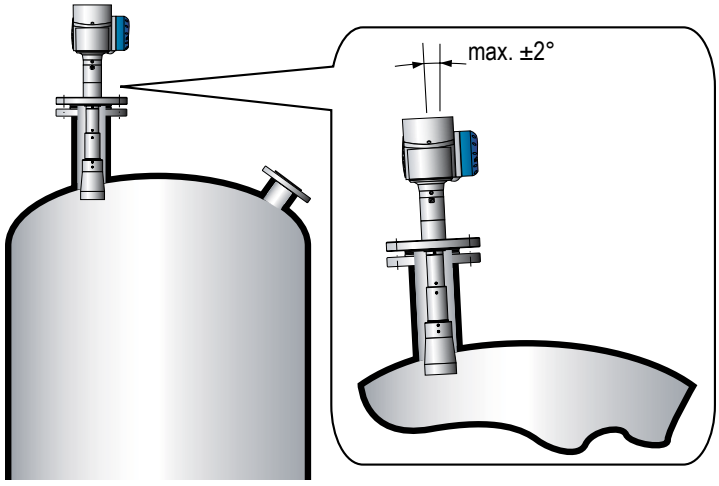


H = The Tank Height (including process connection)
D = The Internal Diameter

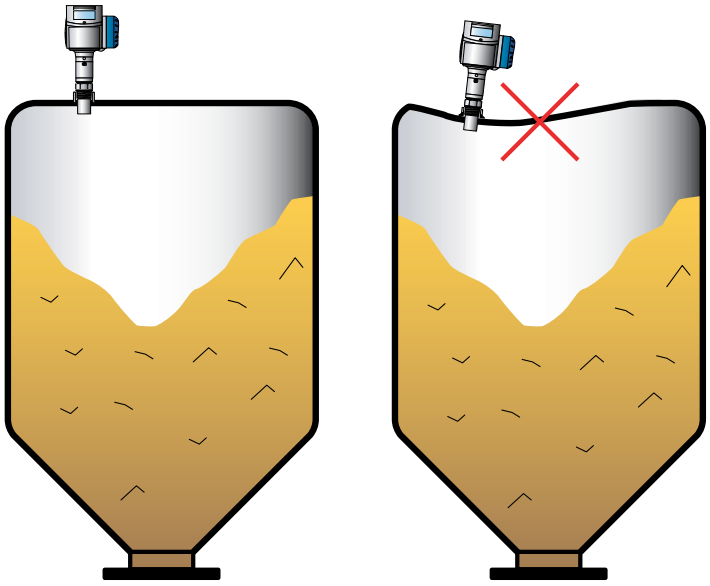
Other specifications for fittings

For the gauge to make accurate measurements and have a good signal reflected back from the product surface:

- Ensure a good fit with the gauge process connection
- The radar must point directly down onto the product. Angle offset tolerance ±2° from vertical

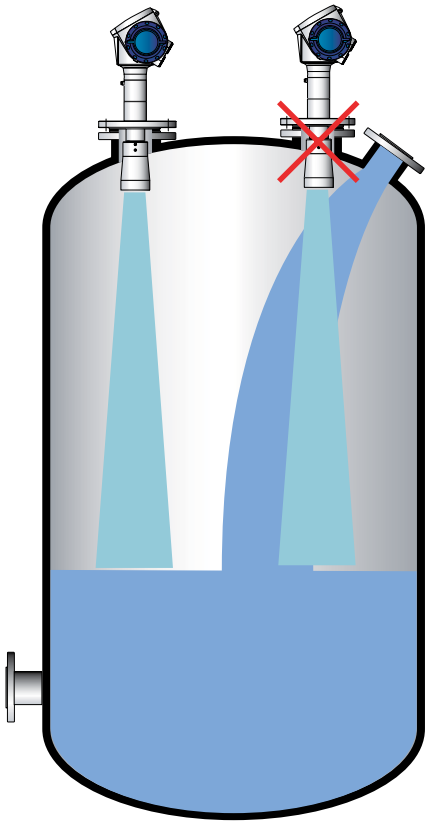


The Tank Roof Must Support the Weight of the Meter



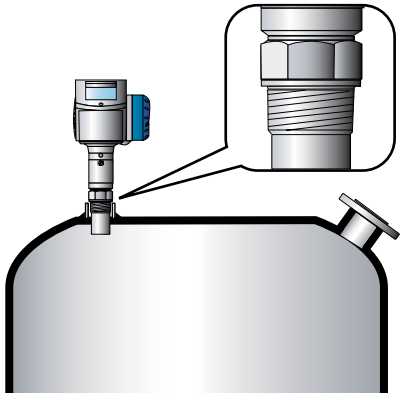
Do Not Put the Process Connection Close to the Entry Pipe

Pouring the product directly onto the antenna or directly below will cause measurement errors.



Threaded Process Connections

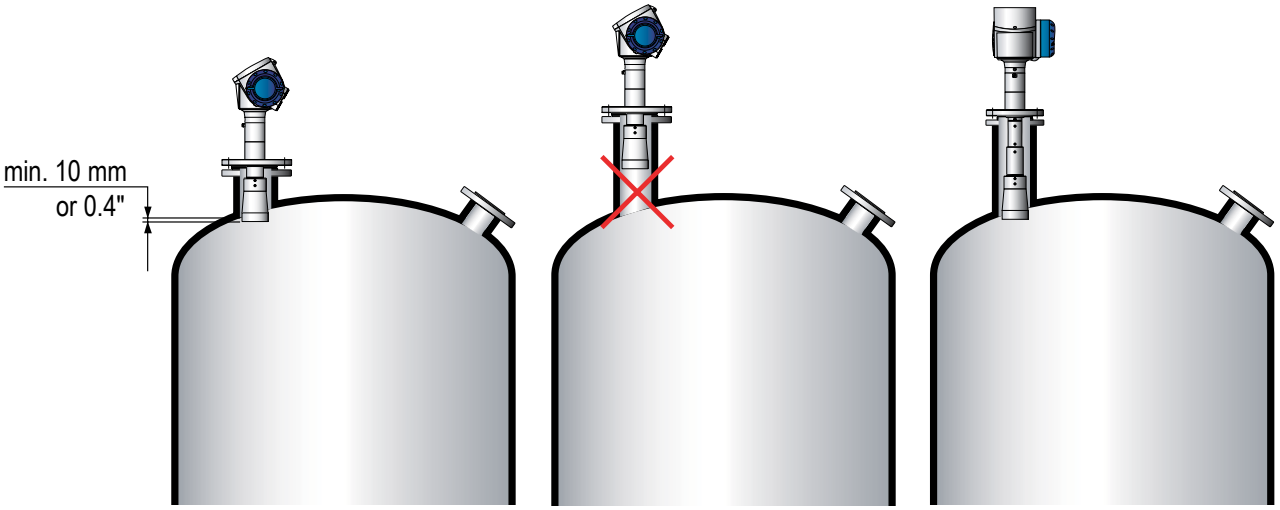
The simplest and most economic way is to mount the level meter directly onto the tank with a GAS or NPT-threaded connection. Use a 50 mm or 2" open-end wrench or similar to screw the device onto the tank process fitting.



Nozzles

To measure the level, the horn antenna must project out of the nozzle by at least 10 mm or 0.4".

If the nozzle is too long, use antenna extensions. Please note, however, that these are only available for the DN 80 horn antenna.



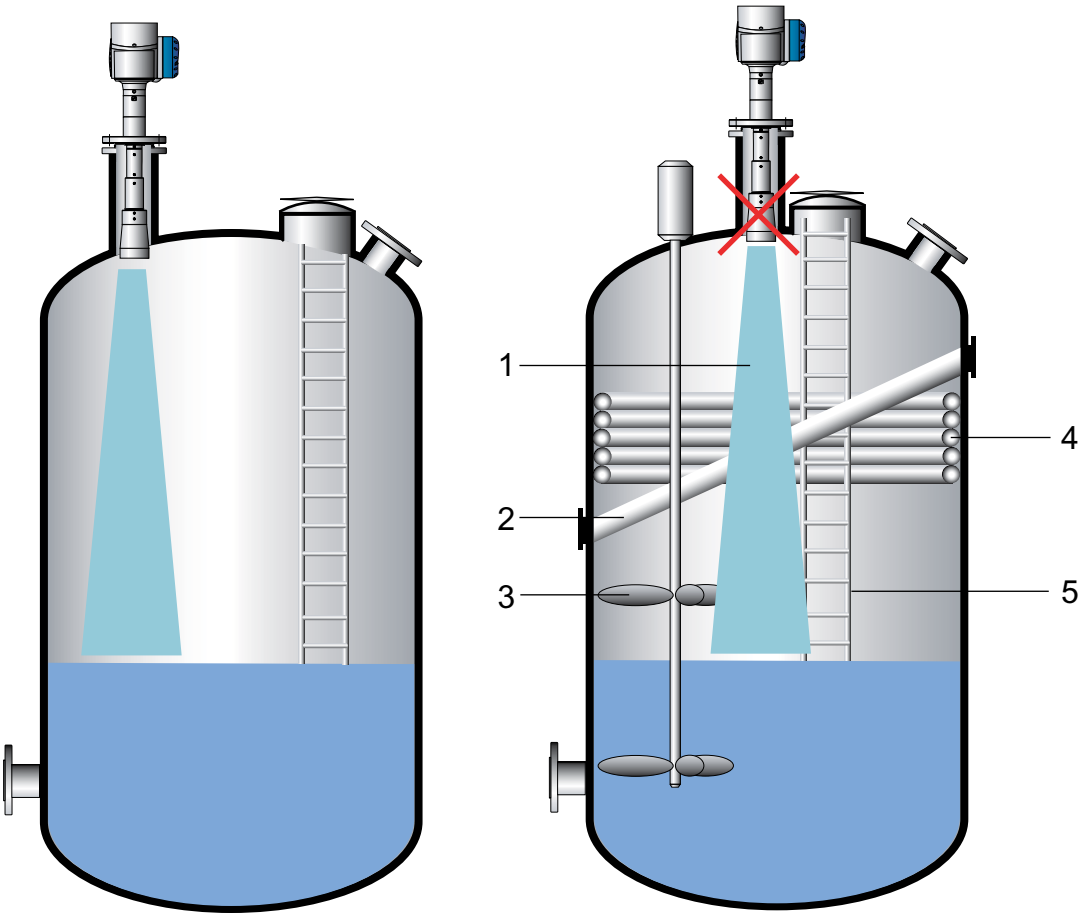
1.2 Installation relative to other tank components

Factors that Influence RADAR Waves

Install the process connection far from the tank wall and protruding objects such as heating tubes, sudden changes in tank cross-section, tank wall reinforcements and beams, weld lines, dip-stick pipes and build up of product. These objects create false reflections that superimpose on the level measurement reflection.

Avoid too Many Objects in the Tank

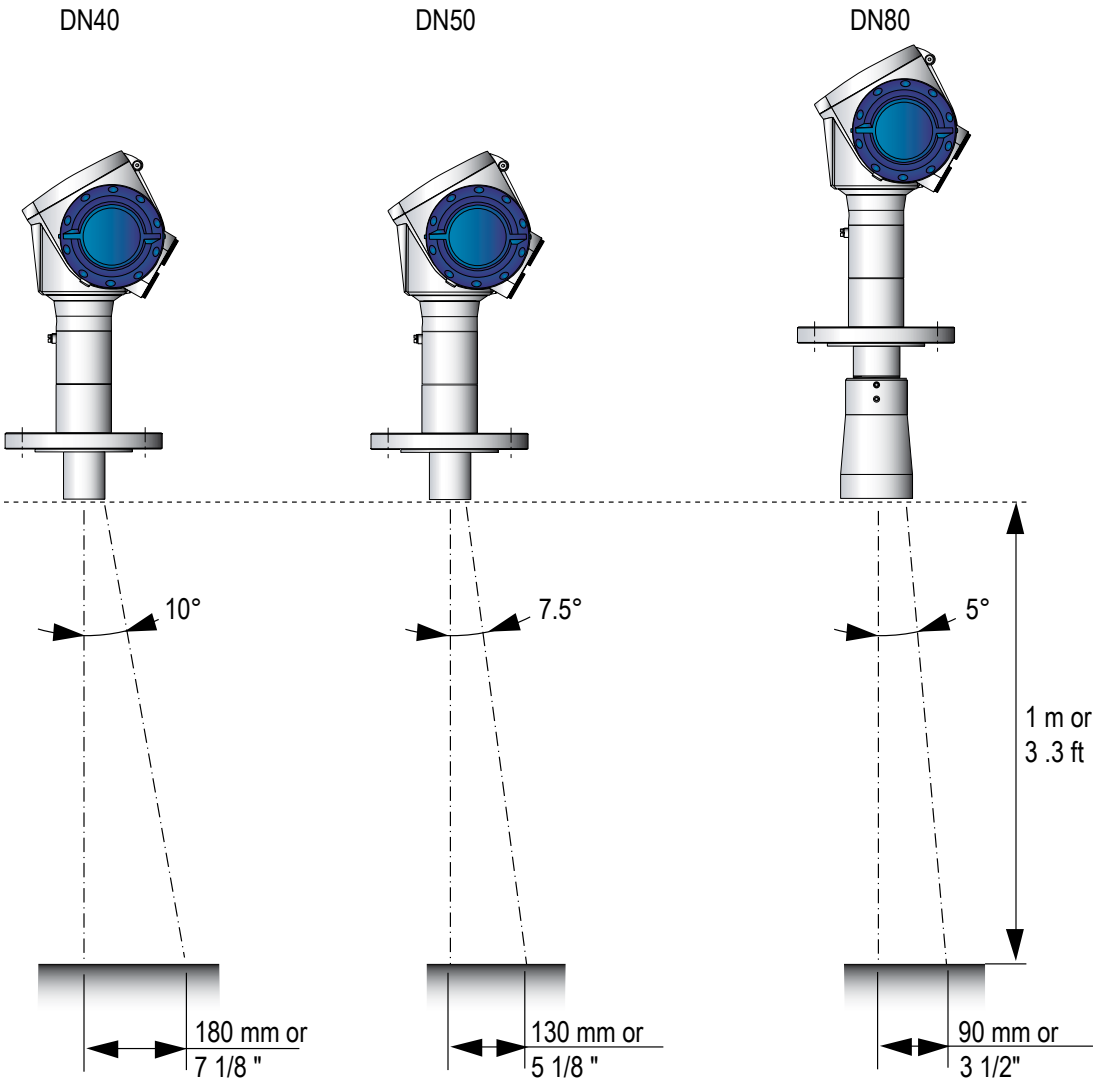
Risk of measurement error



1. RADAR beam
2. Tank support beam
3. Agitator
4. Heating tubes
5. Ladder

To avoid interference with the radar beam, make sure that all tank components are located outside the beam. The beam radius at a distance of one meter is given below. If components are within the beam, we recommend that you use a reference chamber or stilling well.

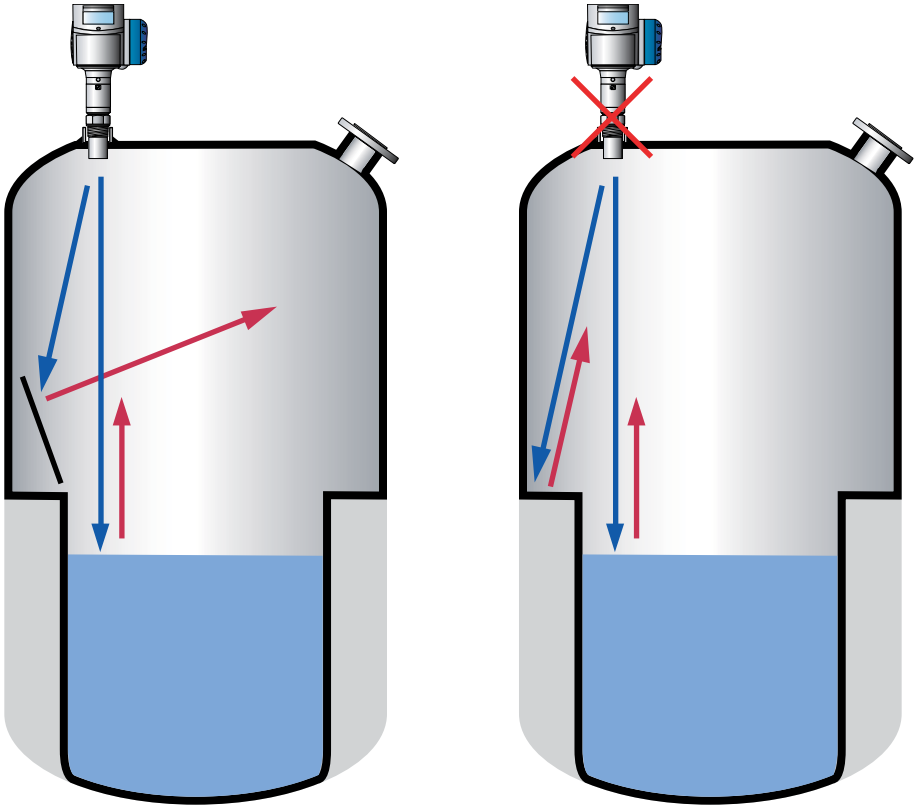
See section 1.3.4 - Stilling wells
Section 1.3.5 - Bypass chambers.



Other ways of avoiding false reflections

False refelctions are caused by obstructions. Obstructions with sharp corners will create big interference signals which can potentially lead to measurement errors while objects with curved surfaces diffuse the RADAR signals but create less interference.

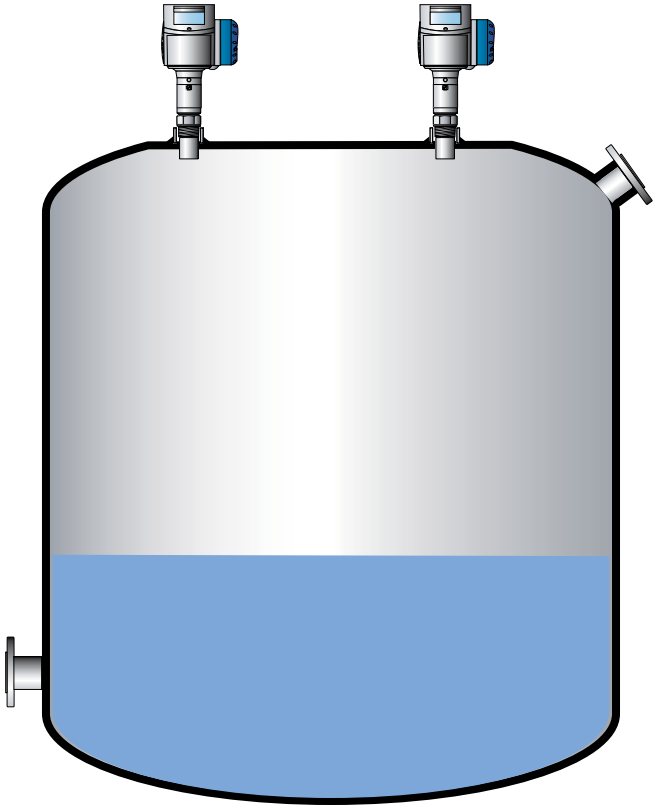
If sharp corners or flat surfaces cannot be avoided, use deflector plates (an angled surface over the zone concerned) to diffuse the RADAR signal and, by so doing, create less interference.



Sharp corners cause multiple reflections - Risk of measurement errors

Installing Two Devices aTank

Install any number of DR7000 radar level meters next to each other on the same tank. However, as mentioned before, do not mount on tank centreline or outside the limits specified in Distance of fitting from tank wall above.



1.2.2 Liquid applications

General Notes

Follow these instructions and those given in section 1.2.1: location, all applications.

Turbulent Products

Install a stilling well or bypass chamber when the product surface is turbulent or a vortex is present. For further information, refer to section 1.3.4: Typical installations; stilling wells and section 1.3.5 - Typical Installations - Bypass Chambers.

Products and Foam

Install a stilling well or bypass chamber when foam is present; especially if it is highly conductive.For further information, refer to section 1.3.4 - Typical Installations - Stilling Wells and section 1.3.5 - Typical Installations - Bypass Chambers.

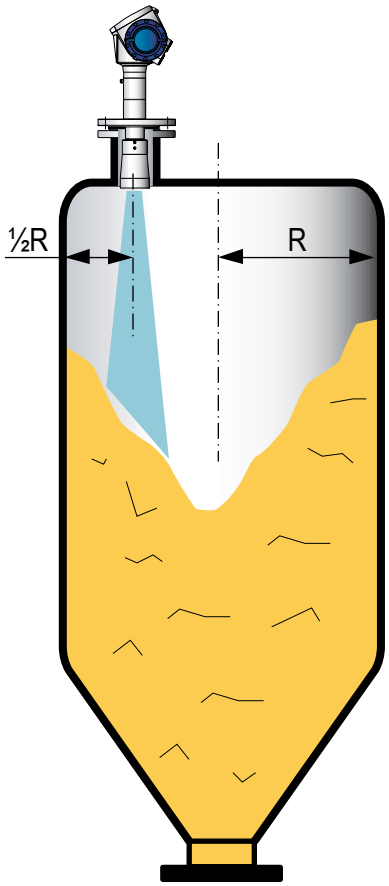
Petroleum Products

These products may be stocked in vessels with moving roofs. Install a stilling well according to local standards, rules and regulations relative to the application and site. Refer to section 1.3.4 - Typical installations - Stilling Wells.

1.2.3 Solid Applications

Location of Process Connections on Conical Silos

Position the connection on the roof at approximatively ½ x tank radius (R) for reliable measurement of product level.



1.3 Typical installations

Electromagnetic compatibility

The DR7000 conforms to European EMC standard EN 61326-1 A1+A2.
The device conforms to EU Immunity and Emissions requirements for residential environments when configured to operate in the open air and in plastic tanks and industrial environments when configured for metal tanks (with appropriate shielding as per radio approval requirements).

Radio approvals - manufacturer's declarations

European Union (EU)

The level measuring instrument DR7000 is intended for installation in closed metallic tanks. It meets the requirements of the R & TTE (Radio Equipment and Telecommunications Terminal Equipment) Directive 1999/05/EC for use in the member countries of the EU.
DR7000 operates using a frequency band (24 GHz - 26 GHz) that is not harmonized within the EU.

According to article 6.4 of the R&TTE Directive, the product is marked by the CE sign + notified body number (0344) + Class II identifier (= alert sign).

CE 0344

According to EN 300 440 (2001-09), the radiated power outside a metallic tank is less than -30 dBm.

United States of America (USA)

DR7000 complies with USA FCC Part 15 Rules (FCC ID JH5-OPTIWAVE7000C) only when installed in totally enclosed metal tanks.
The device has this information fixed below the nameplate

FCC ID JH5-OPTIWAVE7300C

When installed in totally enclosed metal tanks, this device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference which may cause undesired operation.

1.3.1 Installations with difficult measurement conditions

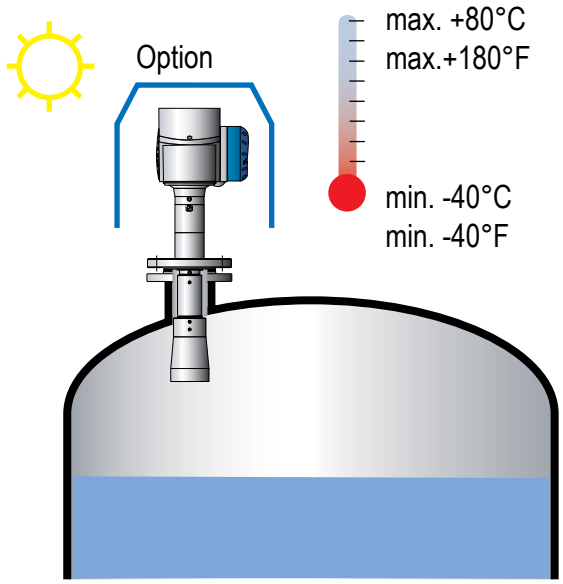
Agitators, other mixing equipment, filling and emptying cycles can cause foam, vortices and turbulent product surfaces.

Mounting a device in a bypass chamber or stilling well are ideal solutions for these condtions.

For further information, refer to section 1.3.4: Typical installations; stilling wells and section 1.3.5: Typical installations; bypass chambers.

Ambient temperature

The ambient temperature limits of the device are given below.

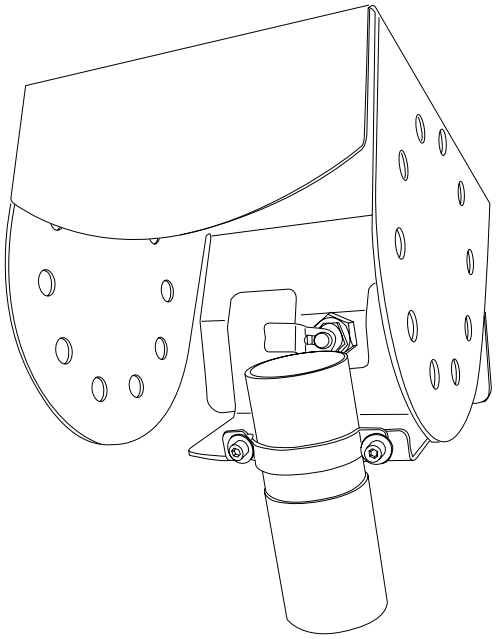


Outdoor installations

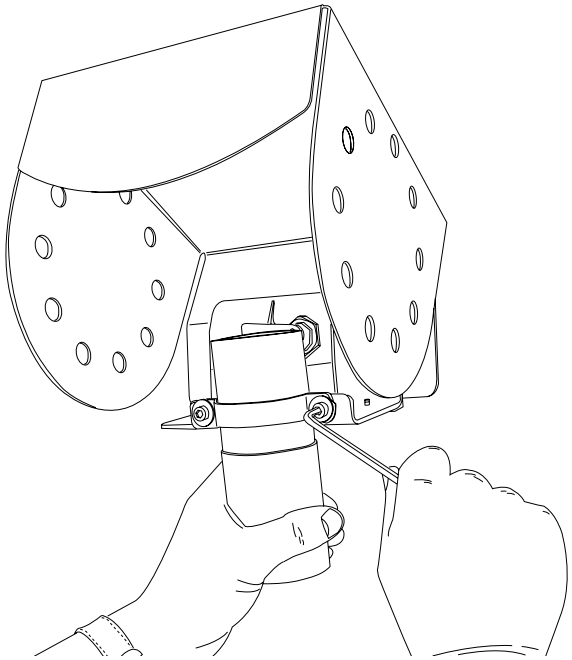
Fit a sunshade on the level meter for outdoor installations: this is supplied on demand.

Procedure - fitting a sunshade

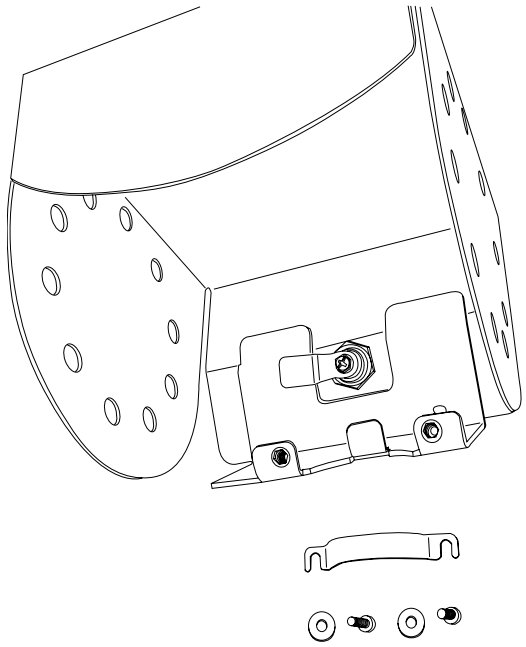
1. The sunshade is delivered separately; attached to a metal tube (A) to prevent deformation of the mounting bracket.



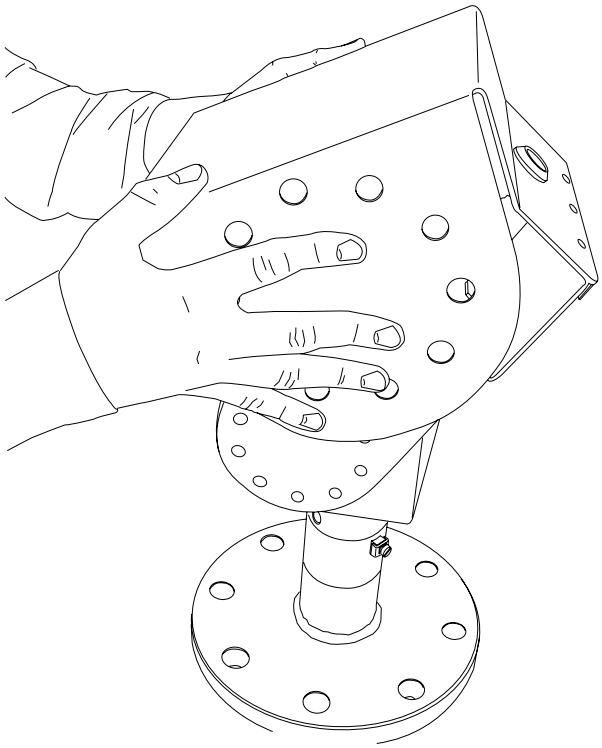
2. Unscrew two M6 socket head cap screws (B) with a 5 mm hexagonal key (C).



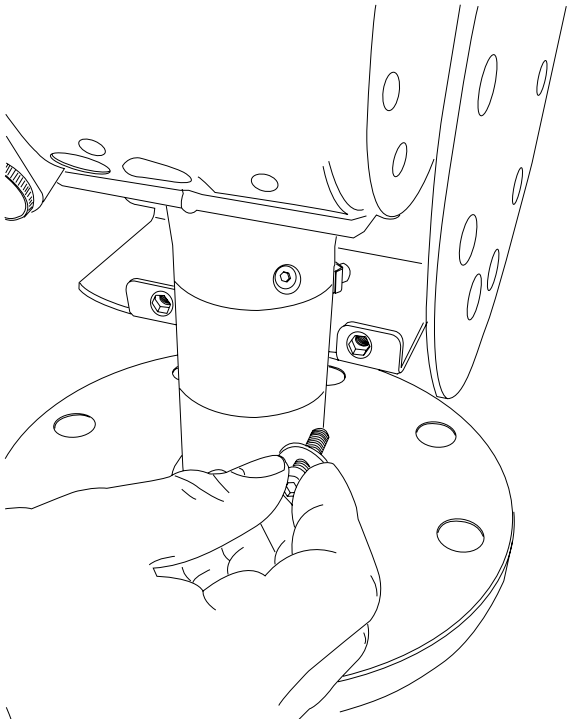
3. Remove the bracket (D) along with two screws (B) and washers (E) from the sunshade (F).



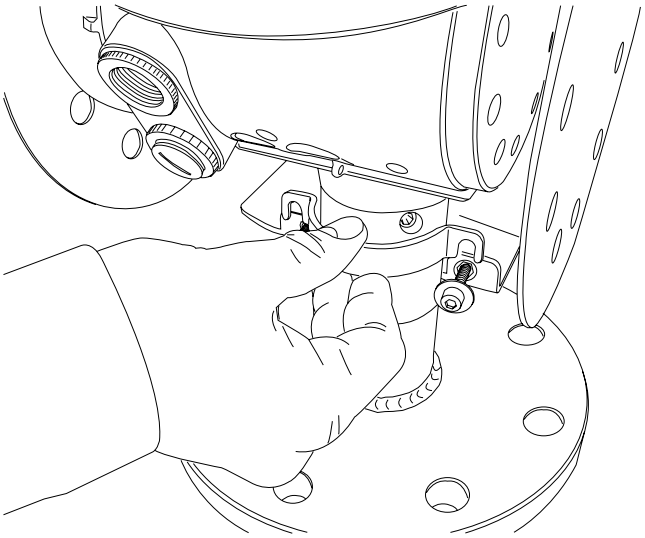
4. Lower the sunshade onto the device. Orientate it so that the “keyhole” (G) is at the front of the device.



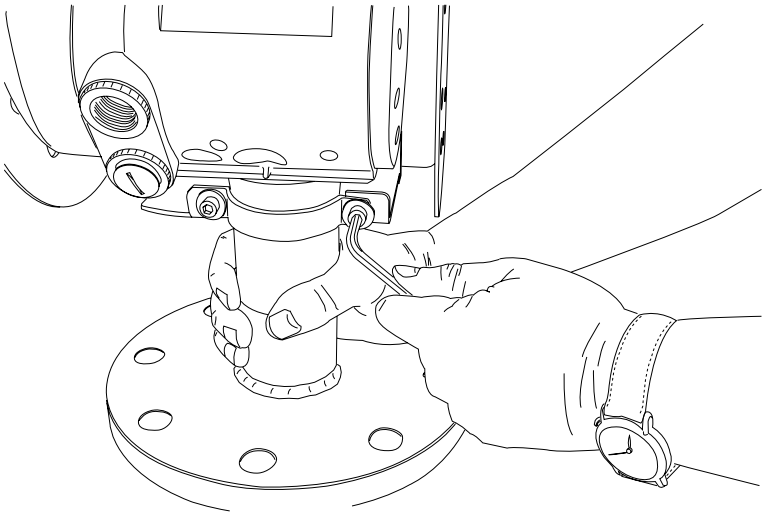
5. Remount the screws and washers.



6. Remount bracket and tighten the screws slightly.

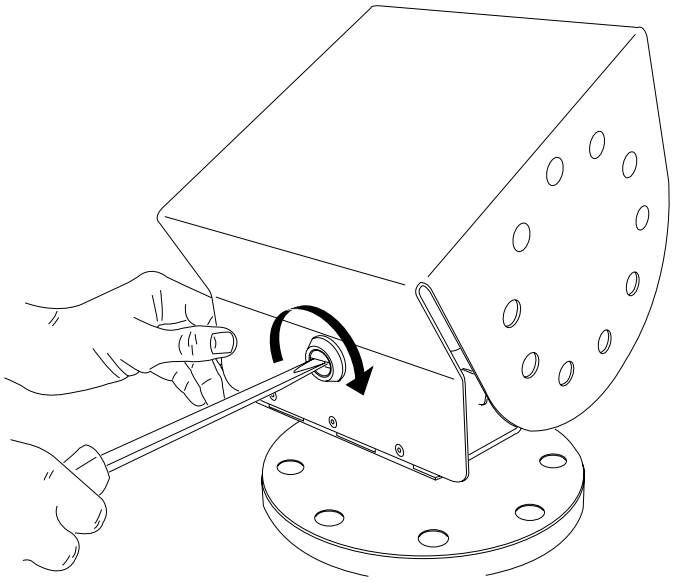


7. Raise the sunshade as high as possible up the housing support pillar by bracing it with one hand. Screw the two bolts tightly so that the sunshade does not slip down the pillar.

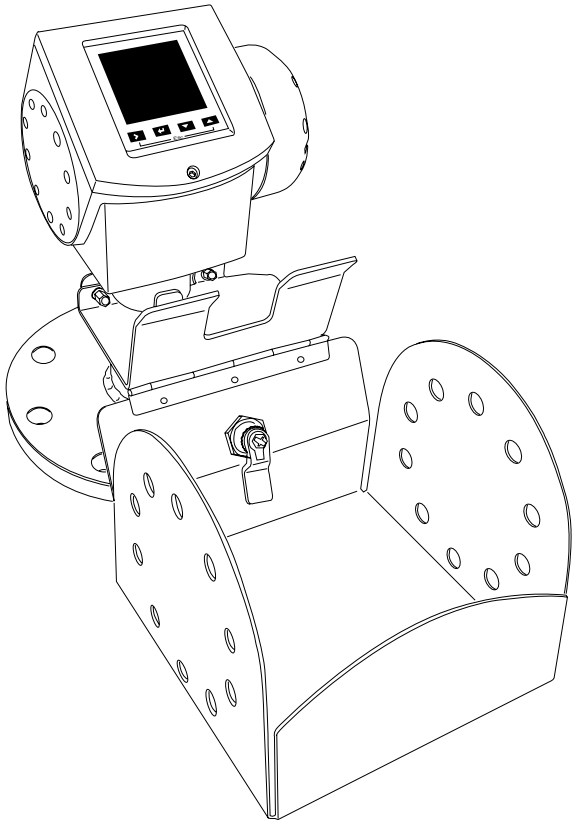


Procedure - opening the sunshade

1. Insert a large screwdriver into the “keyhole” on the sunshade and turn it anti-clockwise.



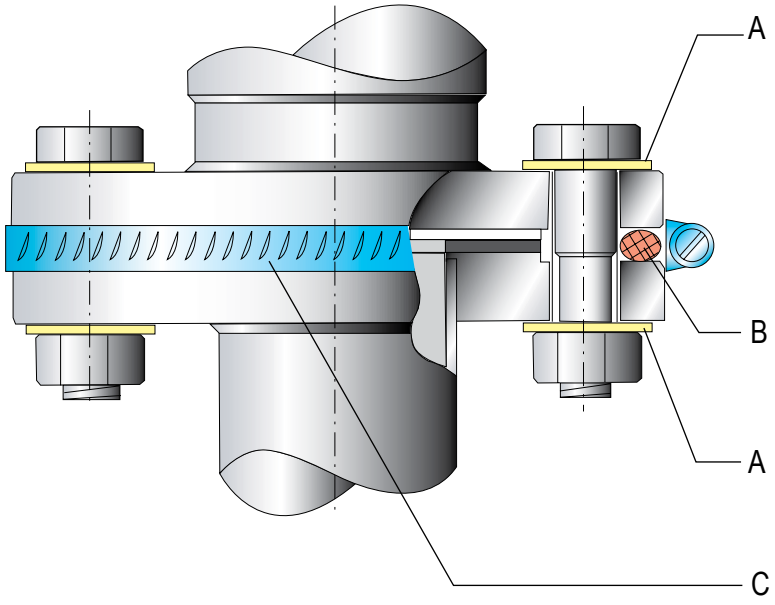
2. The hinge of the sunshade is at the front: pull the back of the sunshade over the device to gain access to the display screen and keypad.



1.3.2 Metallic tanks

Installation has to satisfy radio approval requirements to prevent radio frequency interference (RFI/EMI).
Fit accessories (shown in red, yellow and blue below)

A. Washer under every nut and bolt
B. Metal shielding strip, available on customer demand
C. Strip retainer (metal collar), also available on customer demand
D. Device flange
E. Tank flange

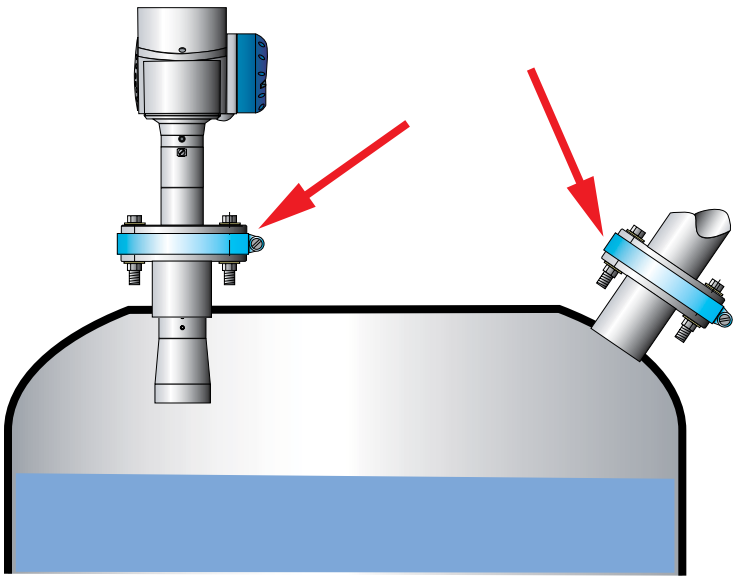


Shielding strip installation procedure

1. Place the gasket on the tank flange
2. Mount the device on the tank flange
3. Align the gasket and the device with the tank flange
4. Fasten the flanges together, making sure that there is a washer (A) under every nut and bolt. The washer must completely cover the flange hole to block RFI. Tighten up the bolts sightly.
5. Press the shielding strip (B) into the gap between the tank and device flanges. Check that the strip goes completely round the flange.
6. Cover the shielding strip (B) and space between the two flanges with the strip retainer (C). Tighten securely.
7. Tighten up the flange bolts. The torque applied depends on local rules and regulations about the bolts's mechanical properties and the process conditions.

Shield all process connections to the tank as described in the procedure above.

Refer to section 1.3.1: Typical installations; general notes for more information on the radio approvals.

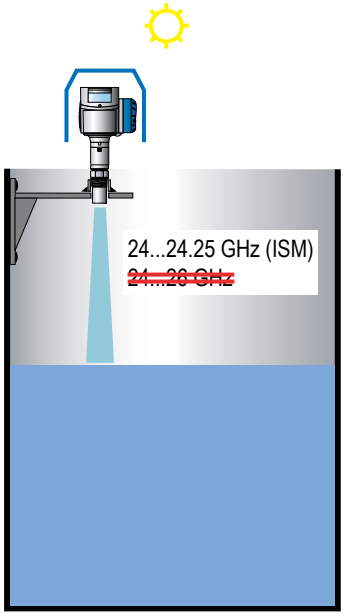


1.3.3 Non-metallic tanks and free air applications

If the device antenna is not totally enclosed, in other words the device is mounted on an open air container or is on a tank made from non-metallic materials such as plastic or fibre glass, the following rules regarding frequency bands apply

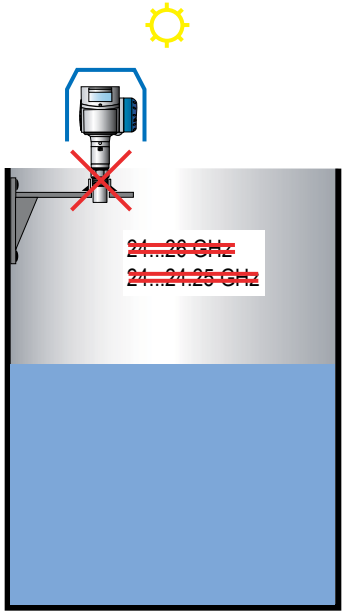
Sites in the EU

Use ISM bandwidth only.



Sites in the USA

Do not use DR7000 on open-air installations or non-metallic tanks.



Refer to section 1.3.1: Typical installations; general notes and Approvals for further installation information.

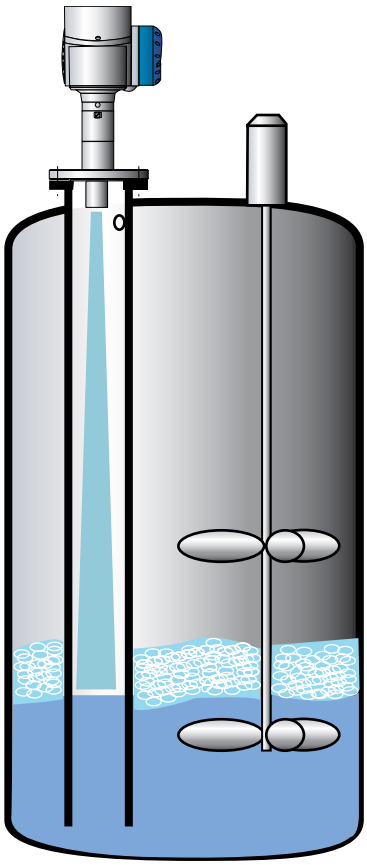
1.3.4 Stilling wells

Applications

A stilling well is recommended for these applications:

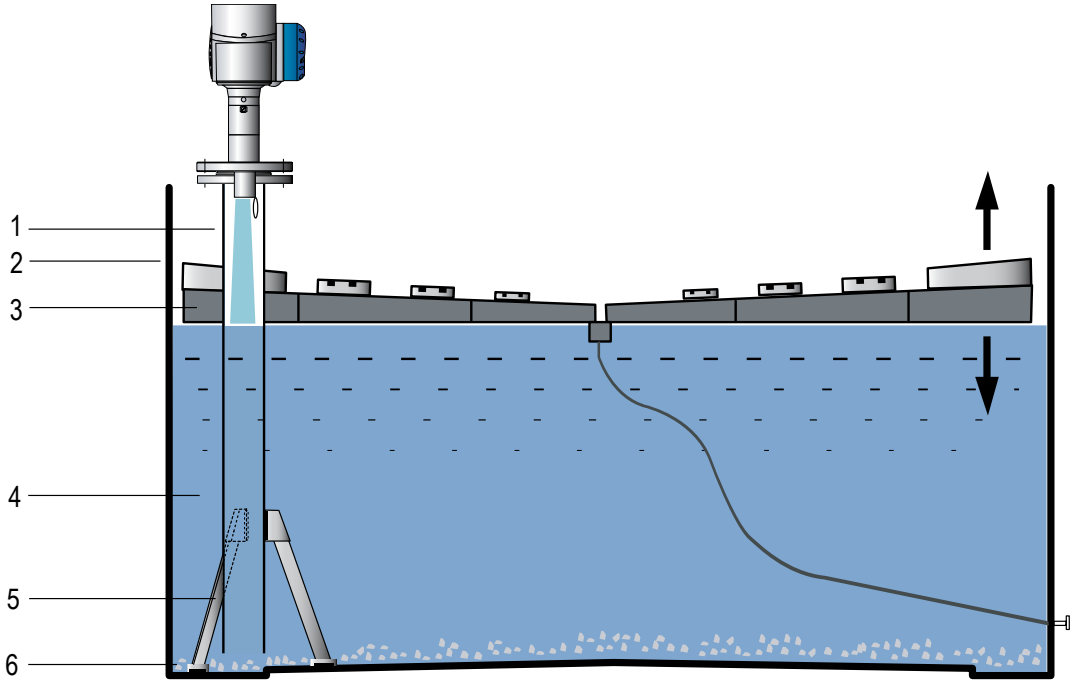
- Where instructions for normal tank installation, such as the distance from tank wall or tank internals, cannot be followed
- Tanks with floating roofs for petro-chemical applications
- Products with foam
- Tanks with turbulent processes
- Low dielectric products

Product with foam and turbulent surface



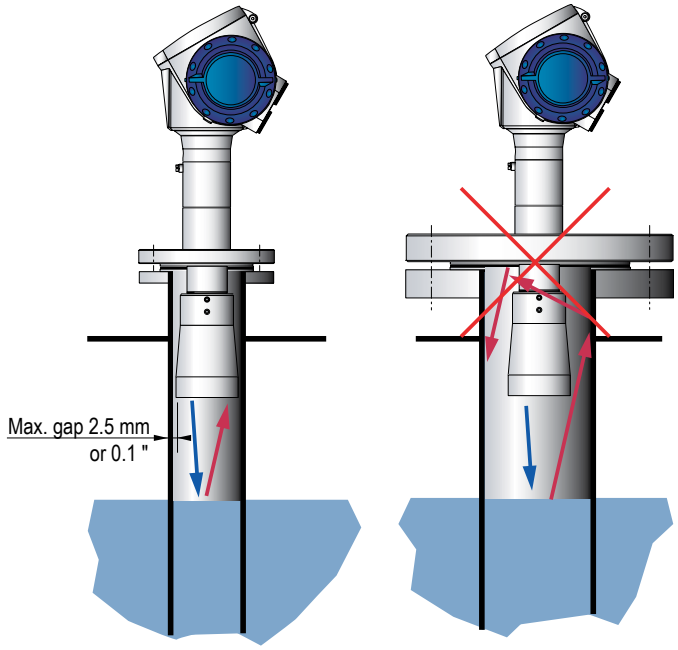
Floating roofs

1. Stilling well
2. Tank
3. Floating tank roof
4. Product
5. Stilling well support legs (fixed to tank bottom)
6. Sediment



Installation requirements

- The walls of the stilling well must be electrically conductive
- The inside diameter of chamber should correspond to the size of the horn antenna (40, 50 or 80 as per order) and be not more than 5 mm (0.2”) bigger than the horn diameter

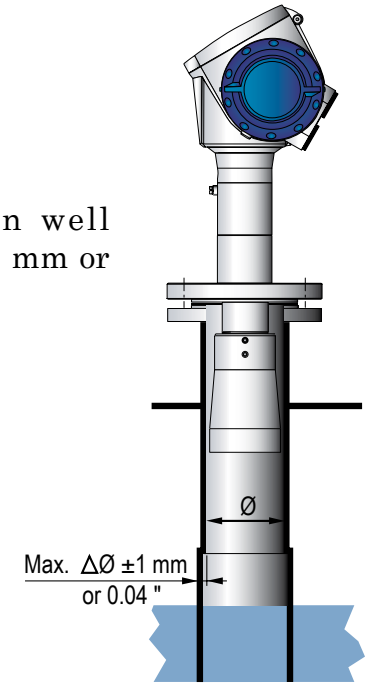


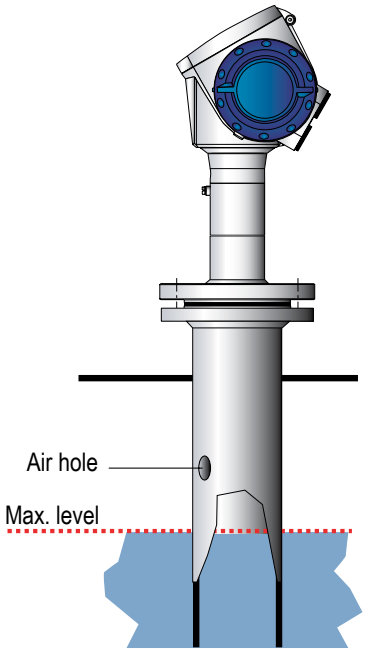
Stilling well diameter too large

Risk of multiple reflections and measurement error

- Stilling well wall must be straight and smooth (surface roughness ±0.1 mm or ±0.004”)

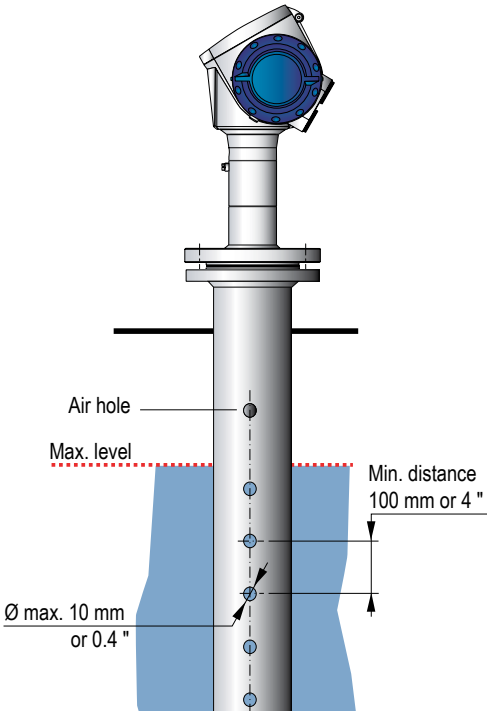
- No abrupt changes in well diameter greater than 1 mm or 0.04"





- Drill a pressure equalisation hole in the stilling well above the maximum product level

- If foam is not present, drill holes along the length of the stilling well: this helps the product to circulate. These must be small, widely-spaced, deburred and along the same axis

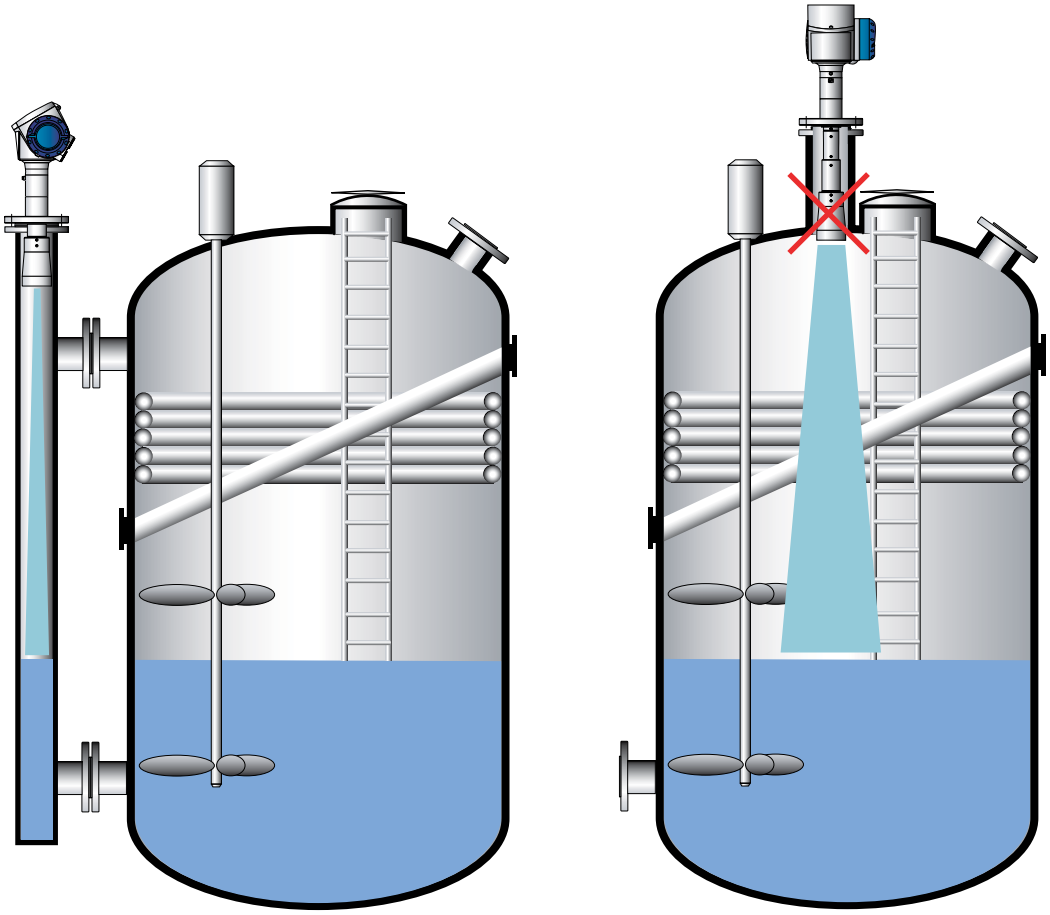


1.3.5 Bypass chambers

Applications

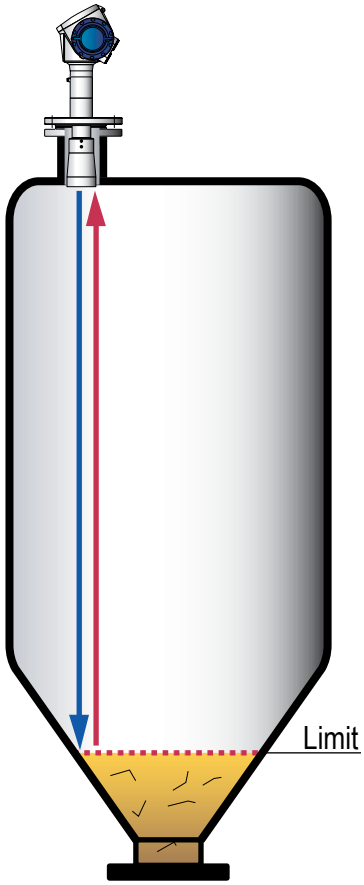
- Bypass chambers are used for applications where there are too many protuding objects inside the tank
- One or more agitators may mean the presence of foam and turbulent product surfaces

These installations have the same requirements as stilling wells. Refer to section 1.3.4: Typical installations; stilling wells.



1.3.6 Conical tanks

When positioning the connection, note that the lower measuring range will be limited when the tank has a tapered base.



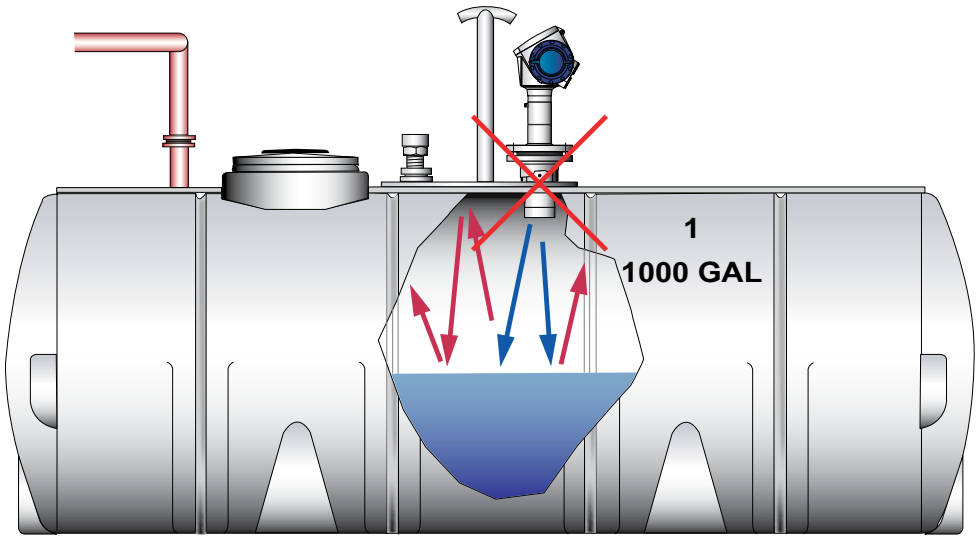
1.3.7 Horizontal Cylindrical Tanks

Applications

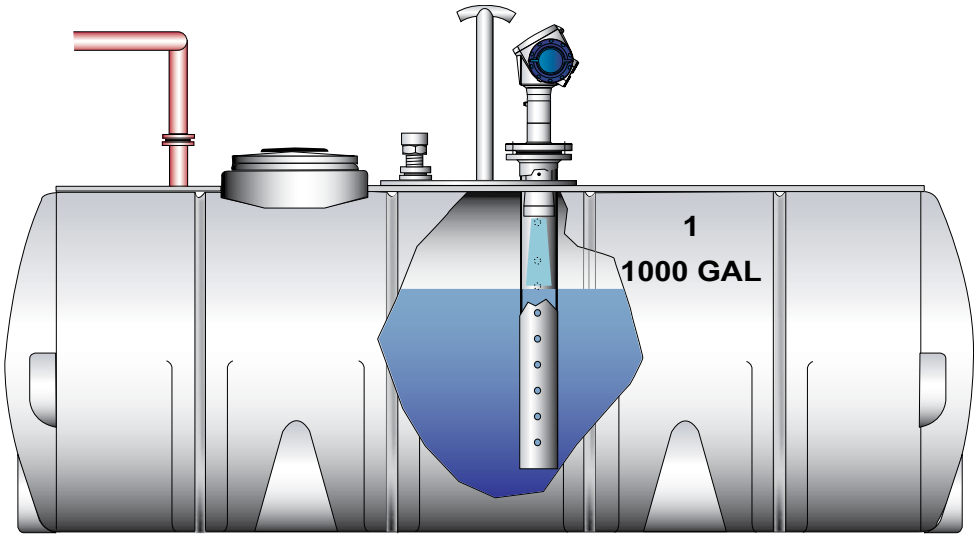
Used for a large variety of applications. Located above or below ground.

Installation requirements

Install the DR7000 meter in a stilling well when mounting on a horizontal cylindrical tank.



Device in horizontal cylindrical tank without stilling well
Risk of multiple reflections and measurement error

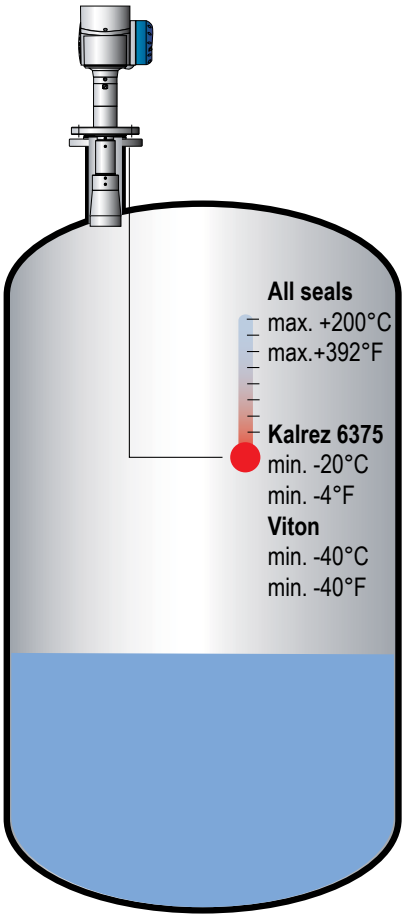


Refer to section1.2: Location, section 1.3.4: Typical installations; stilling wells for further information on installing the device and section 4.2.2: Setup; device display - conversion setup mode for configuring the meter to measure mass or volume in horizontal cylindrical tanks.

1.4 Other important information

1.4.1 Process conditions

Flange Temperature



Process Pressure

Observe process connection operational limits

Risk of injury and damage to device

The operating pressure allowed depends on the temperature at the process connection. The mechanical properties of the process connection are influenced by temperature.

For further information, refer to relevant national standards. For example

European

EN 1092-1 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges

US

ASME B16.5a Addenda to ASME B16.5 Pipe flanges and flanged fittings NPS ½ through NPS 24

2.0 Electrical connection

2.1 Wiring

Cable entry

Electrical connection is made through two cable entries located at the back of the housing. The cable entries can be ordered with adaptors

- M20 x
- 1.5
- ½NPT
- G½

Cable glands are only supplied with non-Ex and EEx ia-approved devices. You must supply the cable glands for EEx d and FM-approved devices.

Access to terminals is via a blue threaded cover on the side of the housing. As the device is a 2-wire instrument, the power supply and the output signal transmitted by the device use the same cable.

Reminder of wiring fundamentals

Power supply

Disconnect the power supply before wiring the device

Cables

- Use metal cable glands and reinforced, shielded cable to minimise RFI (radio frequency interference) and/or EMI (electromagnetic interference)
- Observe applicable local rules and regulations for wiring
- Always use the cable entry facing the terminal
- Avoid crossing or looping wires
- Add sufficient length to make U-bends in the cable to provide water with run-off points
- Do not let the cable come into contact with hot or potentially hot surfaces such as the flange
- Avoid kinks in the cable close to the cable entry glands by adding sufficient cable length. Reinforce with a metal sheath at this point, if necessary

Device protection

- If overcurrent is expected, install an overcurrent protection device
- Earth the device according to applicable local installation standards

American and Canadian installations

- The device must be wired by a qualified electrician in accordance with the latest version of National Electric Code for installations in the USA or Canadian Electric Code for installations in Canada and local regulations
- Check that all wiring is rated 20°C or 68°F above ambient temperature, especially where the cable exits a conduit near to the device.

Supply voltage

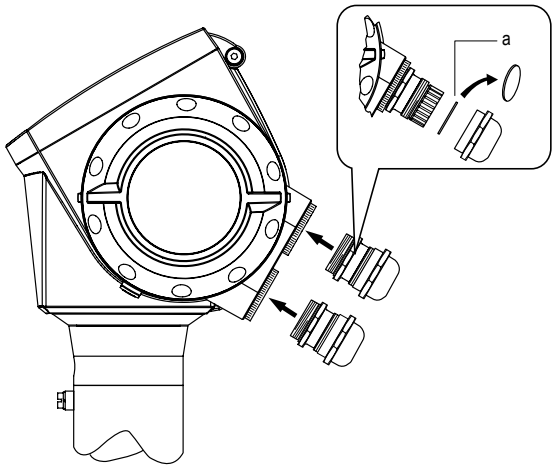
The device requires a supply voltage that depends on which output terminal is used and the approval option ordered.
Refer to section 2.2: Power supply for this information.

Hazardous areas

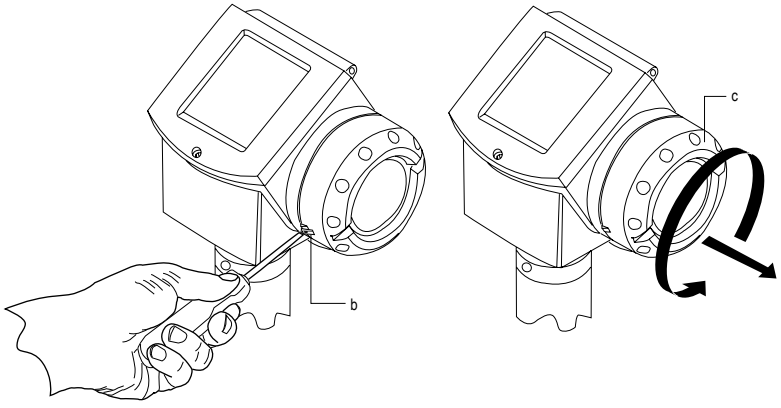
For information on wiring devices approved for use in hazardous areas, refer to the approval certificate and special manuals supplied with the device. See also Standards and Approvals.

2.1.2 Wiring Procedure

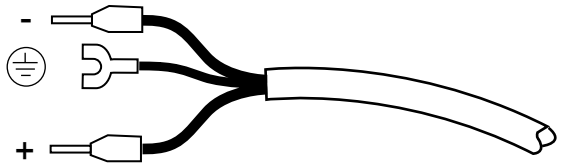
1. Fit cable gland. Disassemble the top of the cable gland, remove plug (a) then reassemble.



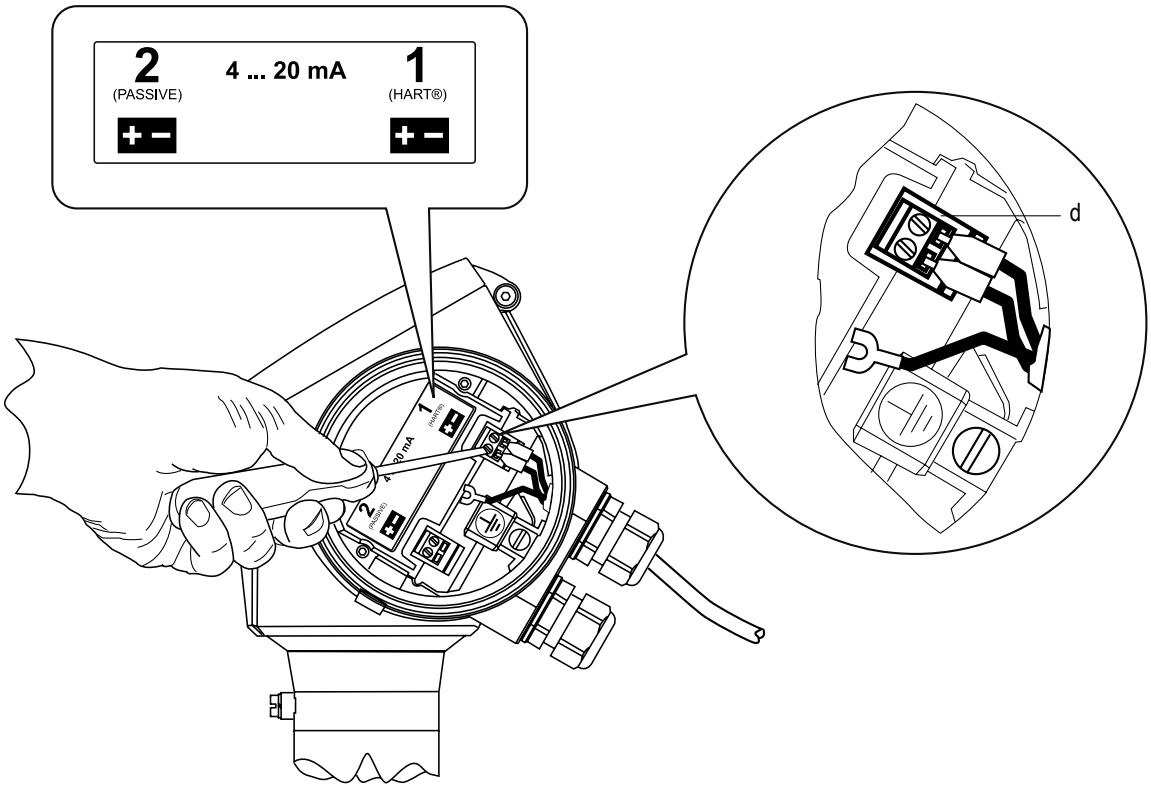
2. Unscrew the M4 socket head cap screw using a 3mm hexagonal key and remove cover stop (b). Remove the wiring compartment cover (c).



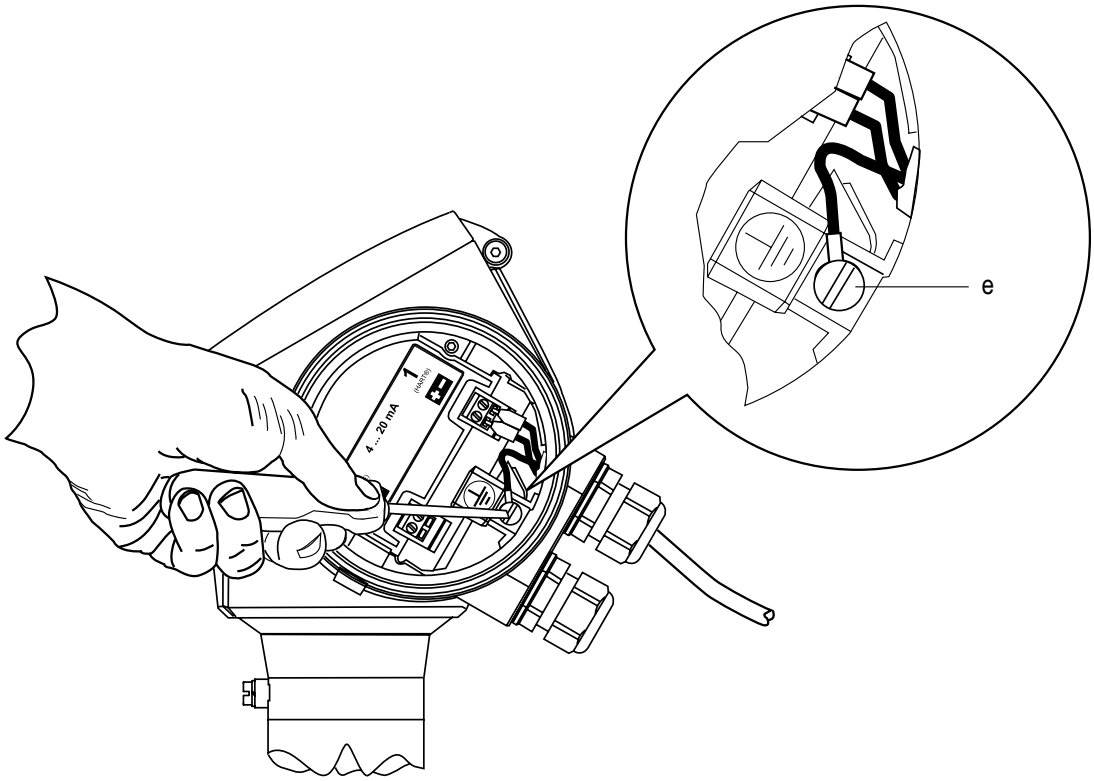
3. Prepare the cable and wires for connection as per local rules and regulations. Insert cable via the top cable gland.



4. Loosen the power supply/current output 1 terminal block (d). Insert the wires into the terminals as per the wiring diagram below. Ensure that the polarity is respected. Retighten screw.

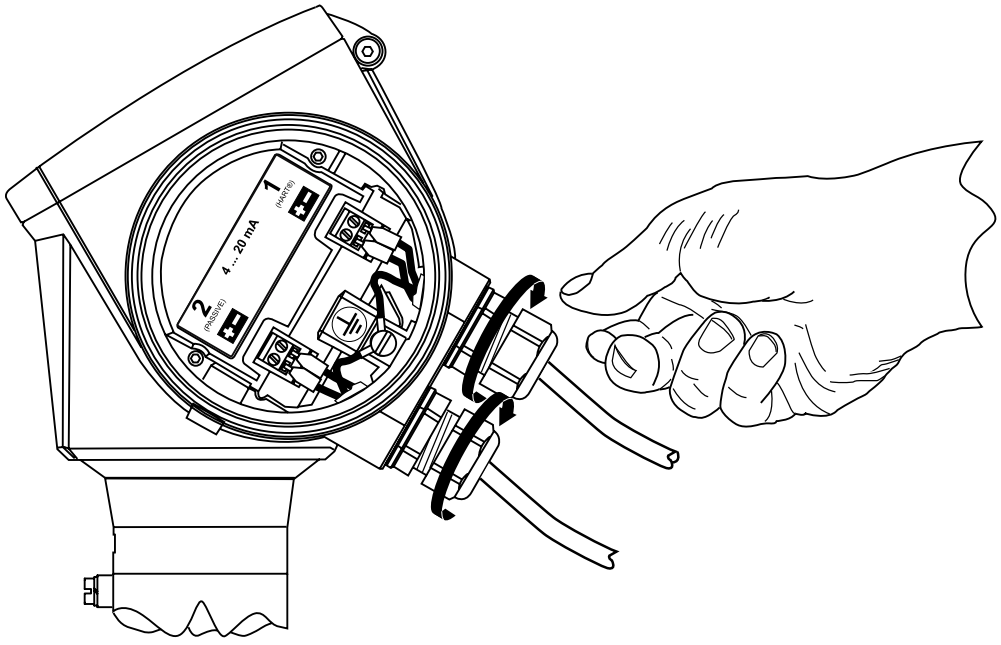


5. Loosen ground terminal screw (e) and insert wire. Retighten screw. See section 2.2.3: Power supply, Ex versions for earth connection (equipotential bonding system) for Ex-approved devices.

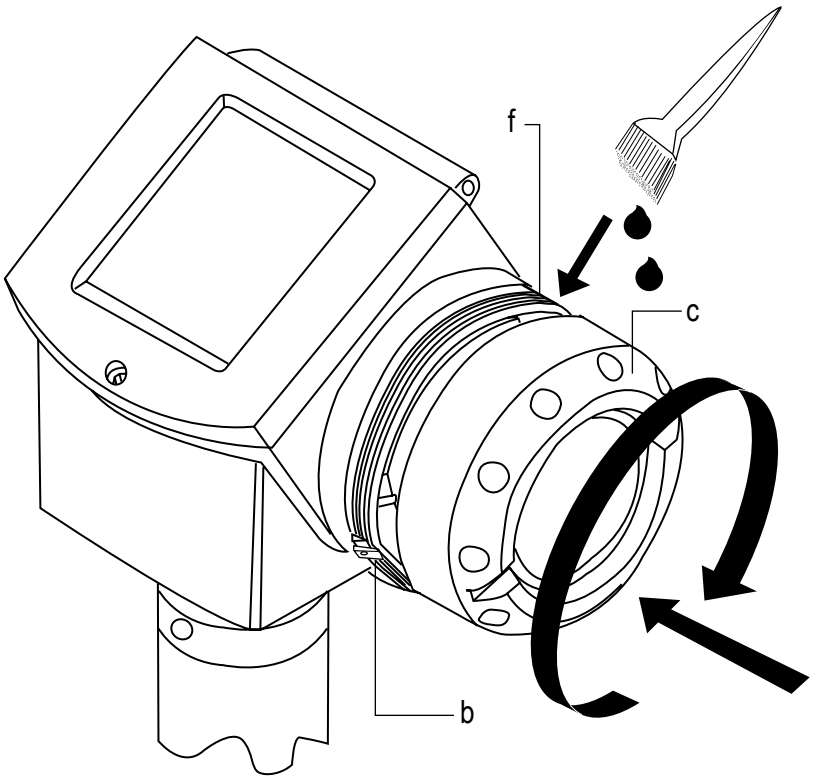


6. Check that the wires are held correctly by the terminals.

7. Retighten the top of the cable gland until the ring forms a seal around the cable.



8. Grease the thread (f) of the wiring compartment cover.
9. Screw on the wiring compartment cover (c). Remount cover lock(b).



10. Go to section 3.1: Commissioning, power-on and start-up before energizing the device to make sure that the device is correctly installed and connected.

Wiring Devices Approved for Potentially Explosive Atmospheres

Please refer to Appendix A for wiring devices for use in hazardous areas.

2.2 Power supply

2.2.1 General notes

Each output requires its own power supply.

Supply voltage outside of given limits

Check that the device uses the correct power supply

- A supply voltage above the maximum value can cause irreparable damage to the signal converter.
- Voltages above and below the specified limits can also lead to faulty measurements or to a device reset.

Refer to technical data in section 2.2.2: Power supply, non-Ex version. If the device is approved for use in potentially
explosive atmospheres, refer also special manuals included with the device.

Power supply polarity

Observe the correct polarity for the devic's electrical system.

- The device will not function if the polarity is reversed

Factors influencing supply voltage

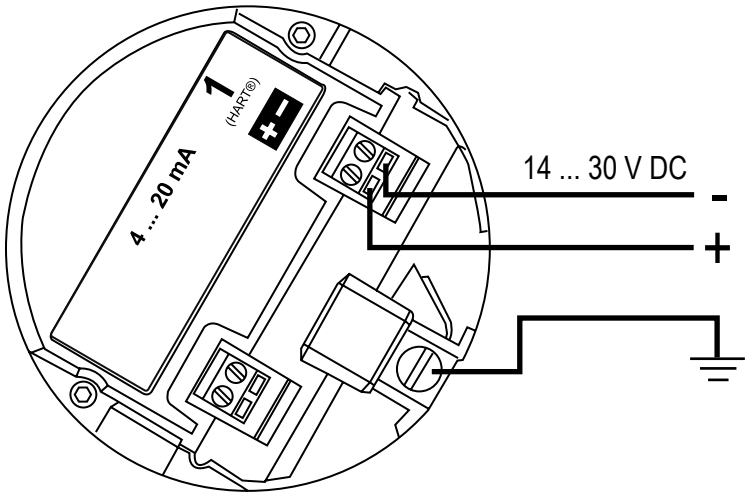
Allow for voltage drop caused by the circuit load impedance (loop resistance). This includes the resistance of:

- The cable
- Other devices in the circuit
- Resistors for connection of device tool managers and HART® controllers

2.2.2 Non-Ex versions

Non-Ex or general purpose version

One output



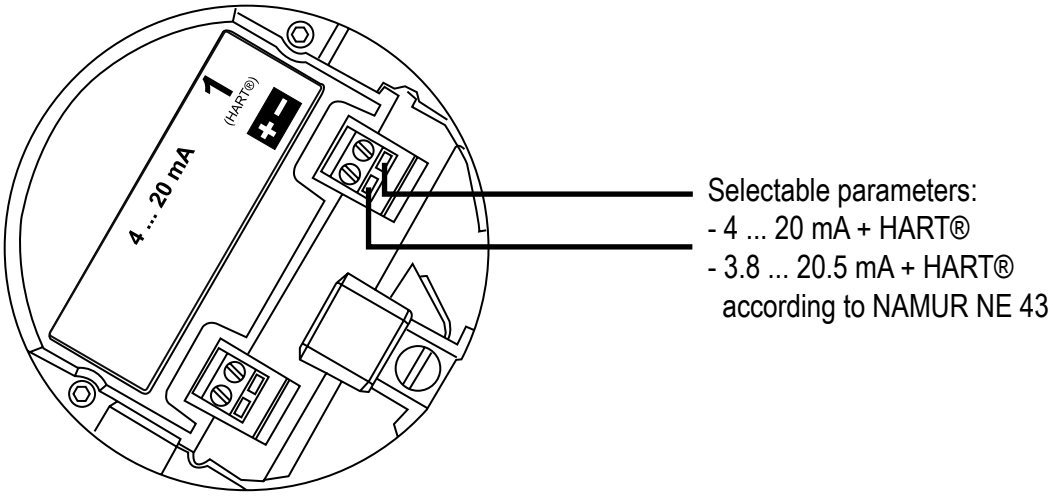
2.2.3 Ex versions

Please refer to Appendix A if approved for use in potentially explosive atmospheres.

2.3 Connection, I/Os

Output options

One output



Network options

There are 3 output versions

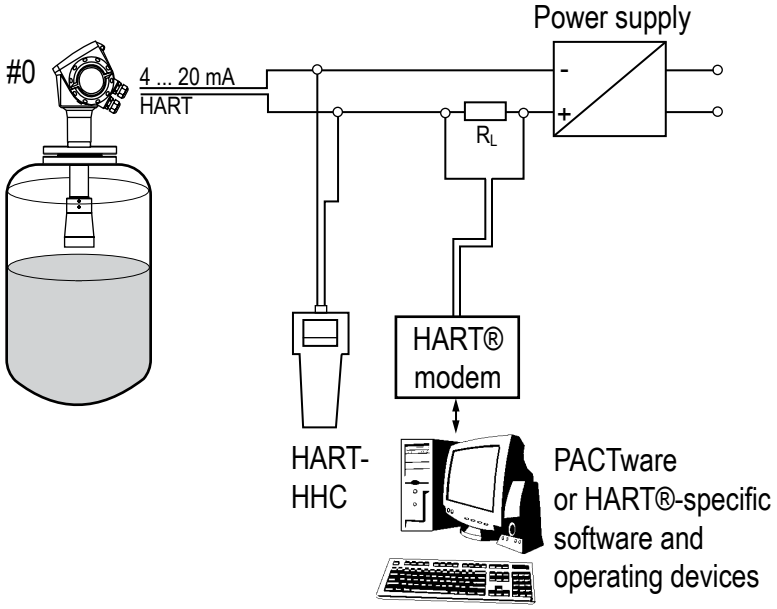
- Current output HART®, passive, HART® protocol
- Current output Ex-ia HART® intrinsically safe; passive, HART® protocol
- Current output Ex-d ia HART® explosion-proof; passive, HART® protocol

The last two versions are discussed in special manuals for devices approved for use in explosive atmospheres.

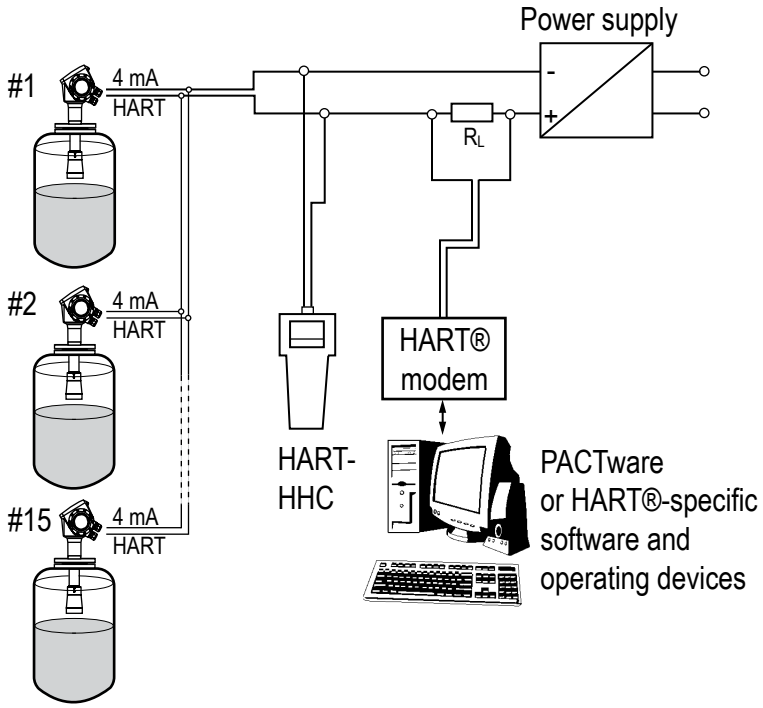
Two network modes are available

- Point-to-point
- Multi-drop

Point-to-point (non-Ex)



Multi-drop (non-Ex)



RL = resistor, approx. 250 ohms

HART® communication protocol

In accordance with the Rosemount Standard, HART® communication can be used with this level gauge. It is used as a point-to-point connection between the slave (this level gauge) and the HART® master or for multidrop networks (up to 15 devices).

Additional information

The following can be called up via the following interfaces:

- Current output: 3.6 or 22 mA for error signal (according to NAMUR NE43 standard)
- Digital HART® interfaces: scanning for error flags and messages.

Changing from point-to-point to multi-drop network mode

The device's output 1 communicates by default in point-to-point mode (HART address 0). If you wish for the device to communicate in multi-drop mode then you have to modify the output's HART address. Use the following procedure

Procedure (using the display screen configuration wizard)

1. Enter Program Mode (Press right key for three seconds)
2. Either go to Quick Setup > Setup mode > Outputs and go through the setup procedure until you get to OP1 (output 1) HART Address
   ...or...
   go to Advanced Setup > Output 1 (HART) and find the menu item HART Address
3. Type in a value between 1 and 15 (default is 0 - point-to-point mode). This will switch output 1 over to multi-drop mode.
4. Check that outputs of other devices in the network do not have the same HART address
5. Exit to Normal Mode

For further information on device operation and configuration, please refer to section 4.1: Operating concept and section 4.2: Setup.

A definition of the menu item HART address is given in section 4.2.3 Setup, summary of user functions under C.4.5.0 HART address.

Networks using Ex-approved devices

Special instructions

Please refer to Appendix A if approved for use in potentially explosive atmospheres.

3.0 Commissioning

3.1 Power-on and start-up

Commissioning checklist

Check the following points before power-on and start-up

- are all wetted components (antenna, flange and gaskets) sufficiently resistant to corrosion by the tank product?
- does the information on the nameplate fixed to the signal converter conform to the operating data?
- has the device been properly installed on the tank?
- have the electrical connections been correctly wired according to national and local rules and regulations?
- Ex devices: please read the special manuals delivered with the device

Start-up

The device requires less than 40 seconds to boot up once connected to the power supply. The device will immediately display measurements of product level.

Other remarks

This level meter is set up and delivered in accordance with your order specifications. You can use the device immediately. If further adjustments are necessary, we recommend configuration of the device using quick setup modes provided in the DTM or optional display screen Wizard.

Refer to section 4.1: Operating concept and section 4.2: Setup for advice on how to use the device display screen Wizard.

4.0 Operation

4.1 Operating concept

Available user interfaces

PACTware

An Open Source, open configuration software for all field instruments that permits clear and concise display of information and configuration of the device from a remote location. Installation is supported by a user-friendly Wizard. Field instruments are easily integrated and the software also allows for future developments.

Display screen

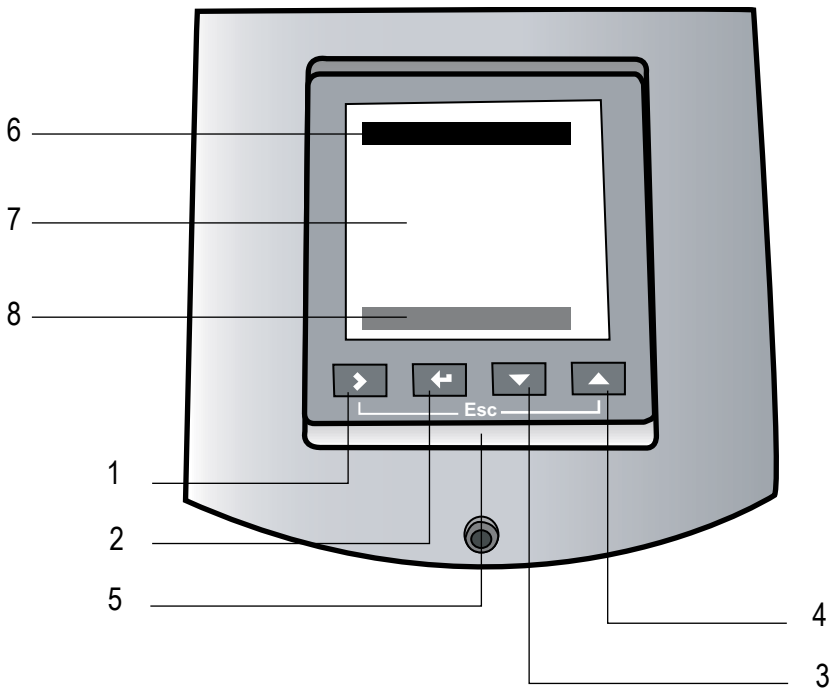
Choose from a large selection of measurement data display options.
Easy configuration via quick setup menus and linked help files (Wizard-driven).
The display screen is supplied on customer demand.

4.1.2 Display screen

Screen layout

The device has an optional 160 by 160 pixels, 9-line display. It has a 4-button pressure-sensitive keypad for selecting display functions and configuring the gauge.

1. RIGHT key
2. ENTER key
3. DOWN key
4. UP key
5. Esc (ESCAPE) function: RIGHT and UP keys pressed together
6. Header bar: displays device tag number when making measurements or error icons and currently selected menu when being configured
7. Main display area
8. Status bar: for displaying results of parameter plausibility checks such as “value too high”

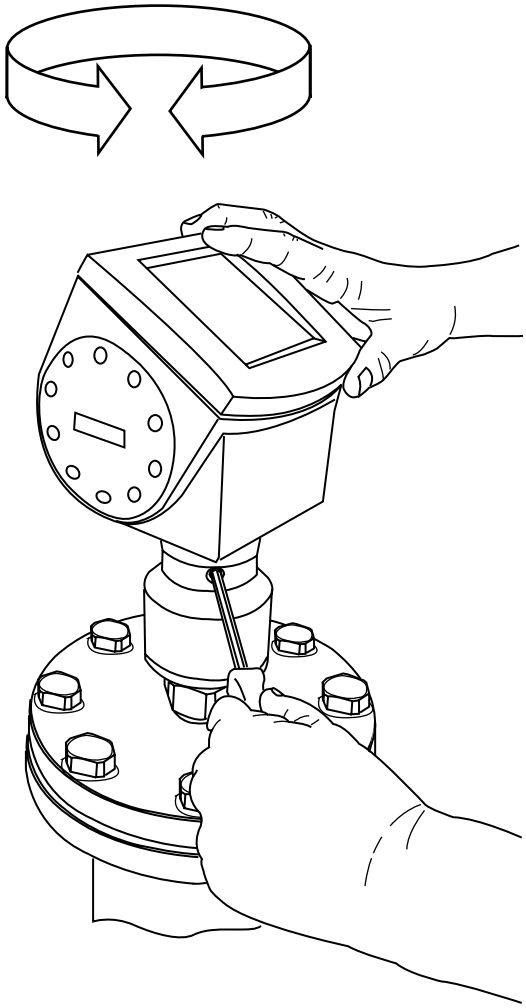


Rotation of display screen

The housing rotates 360° around its base to make reading the display screen and gaining access to the wiring compartment easier.

Procedure

1. Loosen M10 socket head set screw on adaptor connector column below the housing using 5 mm hexagon key
2. Rotate housing and position as required
3. Retighten socket head set screw to fix housing position



The device has two operational modes

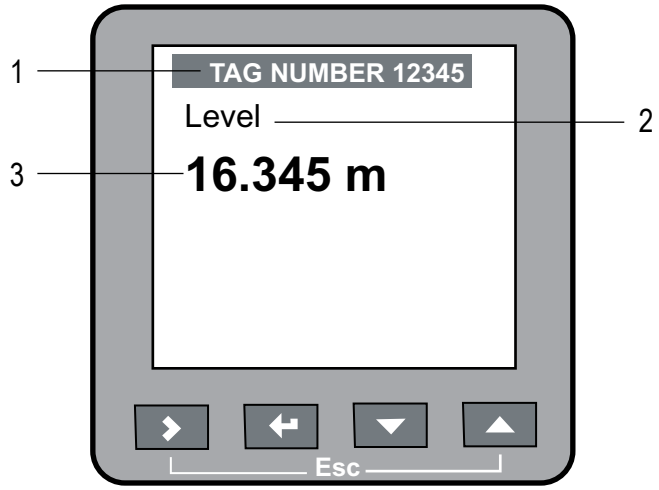
- Normal mode for displaying measurements
- Program mode for configuring the device

4.1.3 Normal mode

Description

The measurement data is displayed on the screen in this mode. Anybody can select what measurement information is displayed (level, volume and types of data) and how it is presented (display style).
This is the instrument's default mode.

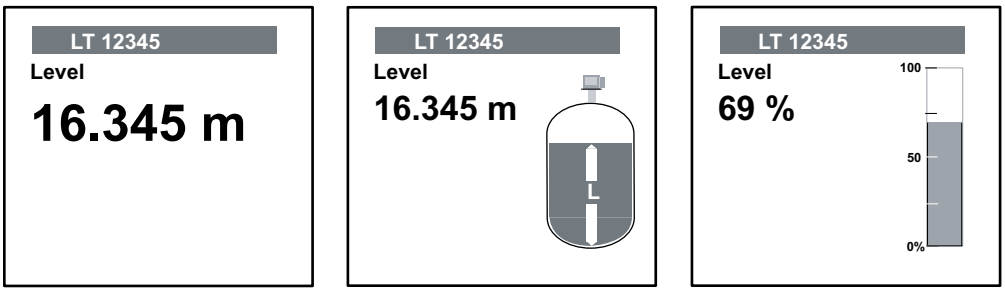
1. Header bar - shows device tag number in normal mode
2. Measurement function
3. Measurement value and units



Display styles

Three display styles are available

1. Value(s)
2. Value(s) and picture
3. Value(s) and bar graph

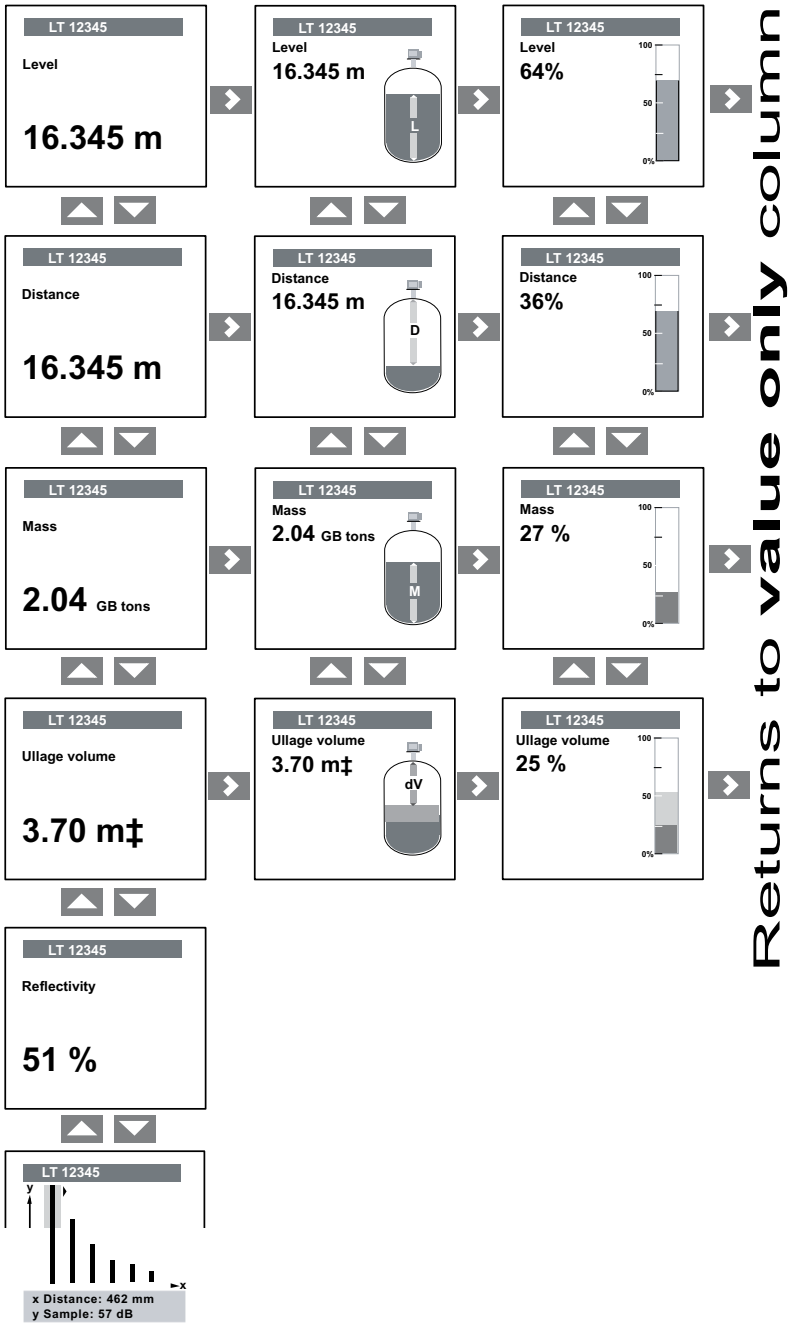


Screen navigation

The following buttons on the keypad are used for Screen Navigation

- Right (>) button: for selecting value, value & picture or value & bar graph display
- Up (s) and down (t) buttons: for selecting measurement (level, volume and so on)

Screens available for a device with one output

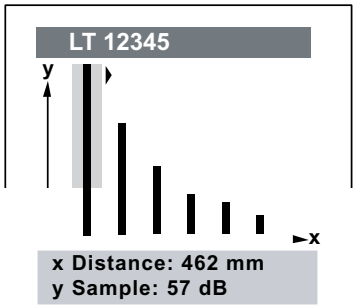


Special note: signal spectrum screen

This shows a graph of discrete RADAR reflection values in decibels against distance following digital processing of the RADAR signal.

The top 5 to 10 spectra (lines) will be displayed and the user can move to the next value to the right using the right button. The size of the spectra and and their distance from the device flange facing are displayed at the bottom of the screen.

Where difficult conditions exist, press the right key for 3 seconds to enter editing mode then press the right button to select a line which corresponds to product level and press enter to confirm.

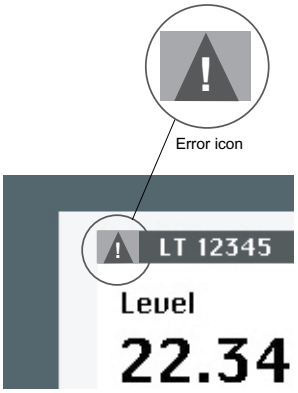


For further information, please refer to section 4.1.4: Normal mode hot keys and section 4.2.4: Advanced setup-further notes.

Icons in normal mode

Error icon

When a problem is detected in normal mode, an error icon is displayed on the left of the display's header bar. This is illustrated in the diagram below. The error icon will remain displayed until a user with supervisor access rights views the program mode menu item B.2.12.0 Error records. See section 4.2.4: Advanced setup-further notes.



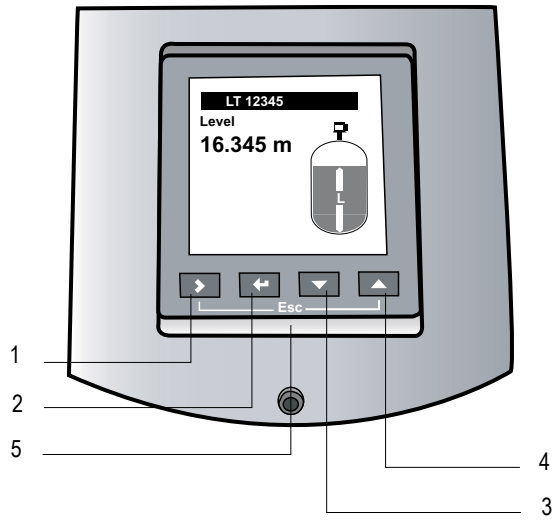
4.1.4 Normal mode hot keys

Hot key activation

Press the screen keypad buttons for 3 seconds to activate hot key functions.

Functions

Item	Key Description	Action
1	Right	Enters program mode**
2	Enter	Enters signal screen edit mode***
3	Down	n/a
4	Up	Screen displays English text (default option)
5	Escape*	n/a



* Press right (>) and up (▲) keys simultaneously for three seconds

** Only when signal screen is displayed. Refer to section 4.1.5 Program mode for further information

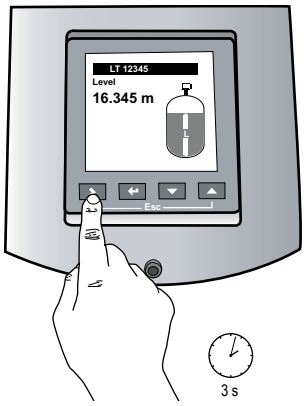
*** Refer to Section 4.2.4 Advanced setup

4.1.5 Program mode

Description

Using this mode, a user with the supervisor password can configure the device.

Entering program mode



1. Press right button on the keypad for three seconds to enter program mode.

2. If the password function has been activated, the device will prompt the user to whether access is required to the supervisor or service menu items. Make a choice from list by scrolling with the up and down buttons and then press the enter key to confirm.

3. Type in the supervisor password. Use the four buttons below the display screen.

   The default supervisor password is right, enter, down, up, right and enter.

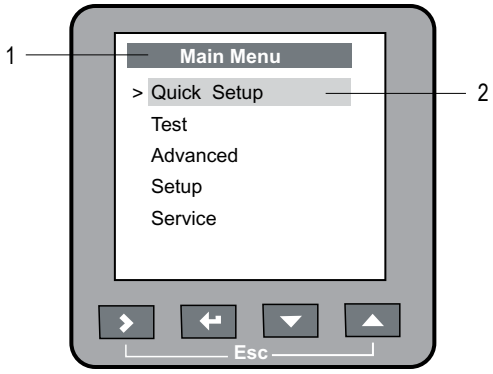
4A. If the password is entered correctly, the screen will show the main menu. The name of the menu or sub menu entered is shown on the header bar.

4B. If the password is entered incorrectly, the screen will return to normal mode.

Refer also to section 4.2.4: Advanced setup: further notes.

Menu navigation

1. Header bar - shows current menu level
2. Selection bar - indicates which menu item is selected



Key	Key Function
Right	Selects next menu level
Down	Movesselection bar down
Up	Moves menu selection bar up
Escape*	Returns to previous menu level

* Press right and up keys simultaneously

Functions

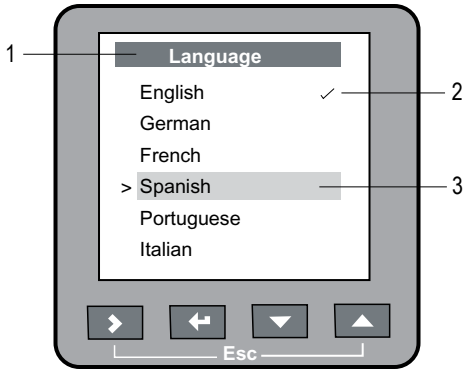
Types of parameters

Two types of parameters can be edited

- Lists
- Values (numerical or alpha-numerical digits)

Editing lists

1. Header bar - shows function name
2. Tick - shows which parameter is currently used by the device
3. Selection bar - shows which parameter is selected by the user. Press enter to confirm selection.



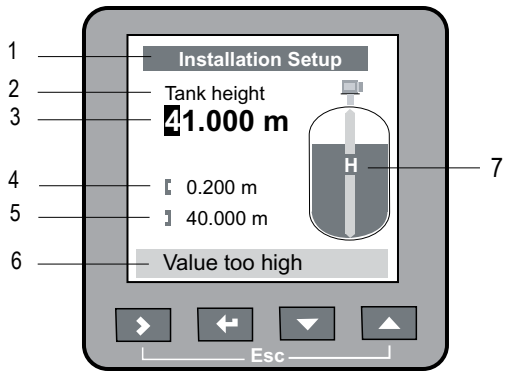
Key	Key function
Right	Moves cursor to the next digit
Down	Decreases digit value
Up	Increases digit value
Enter	Confirm change and exit
Escape*	Exits without confirming

* Press right and up keys simultaneously

Editing values

A value must be modified digit by digit. The cursor starts at its default position on the digit the furthest to the left on the edit screen.

1. Menu name
2. Function name
3. Parameter value with cursor on left digit
4. Minimum value
5. Maximum value
6. Status bar - "value too high" or "value too low" message if value is respectively greater or less than the parameter range
7. Picture of parameter

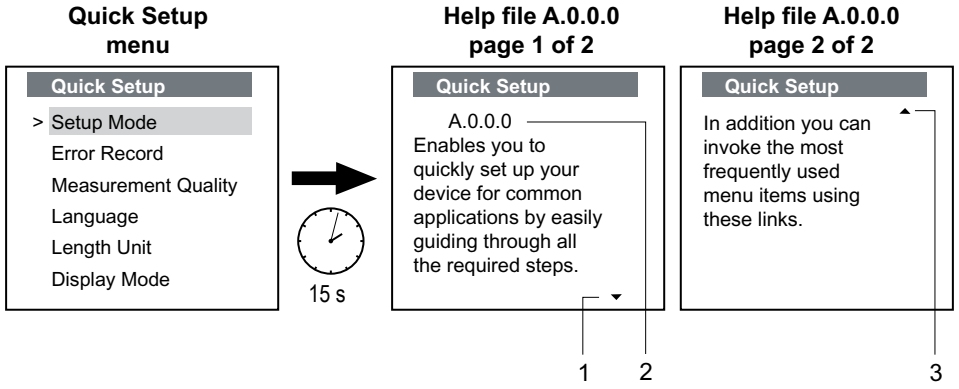


Key	Key function
Right	Moves cursor to the next digit
Down	Decreases digit value
Up	Increases digit value
Enter	Confirm change and exit
Escape*	Exits without confirming

* Press right and up keys simultaneously

Online help

Unsure of the next step? Wait 15 seconds and a definition of the menu item will appear.
Return to the menu screen by pressing "Escape" (right and up keys).

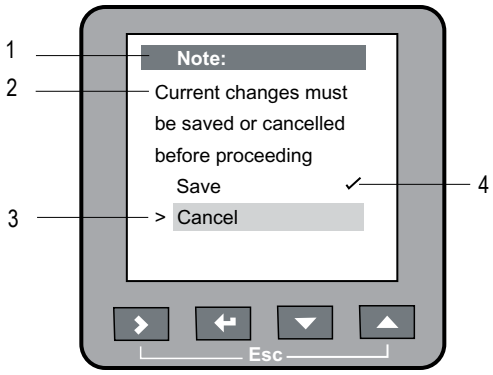


1. Press "down" to read the end of the message
2. Menu reference number. Refer to section 4.2.3: Summary of menu items for a complete list
3. Press "up" to go back to the top of the message

Returning to normal mode

Press escape several times to return to the Main Menu in program mode.

Press escape again to return to normal mode. If changes have been made to settings, the user will be prompted by the device to either save or cancel these changes. In either case, pressing enter will return the screen to normal mode.



1. Header bar - prompt message
2. Message
3. Option selected by user (cancel save). Press Enter to confirm
4. Option currently selected by the device

For a list of device functions and their parameters, please refer to section 4.2.3: Summary of menu items.

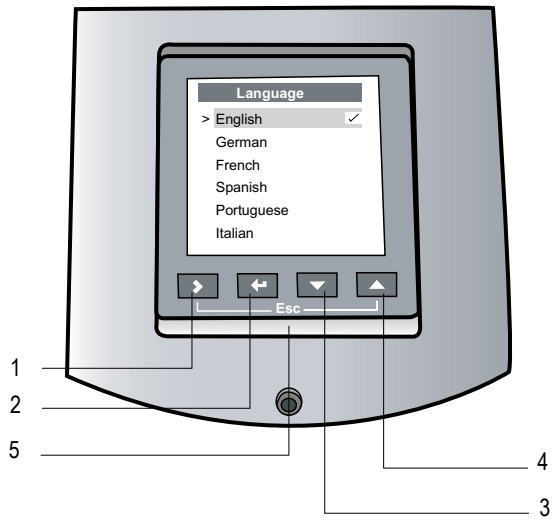
4.1.6 Program mode hot keys

Hot key activation

Press the screen keypad buttons for 3 seconds to activate hot key functions. Read below for details

Functions

Item	Key description	Action
1	Right	Defines function being used as a quick link**
2	Enter	Not used
3	Down	Not used
4	Up	Screen displays English text (default language option)
5	Escape*	Home. Jumps back to last screen displayed in normal mode



* Press two keys (right and up) simultaneously for escape key functions
** The function in question is saved to one of the five Quick Links in the Quick Setup menu. See start of section 4.2.2 Device display for navigating to these quick links

4.2 Setup

4.2.1 Device display

General notes

Using the device display's program mode, configure using one or both methods given

- Quick setup: setup modes
- Advanced setup

4.2.2 Quick setup: setup modes

Wizard-driven step-by-step procedures for easy and rapid device setup in standard applications. Online help is available when clarification is required.

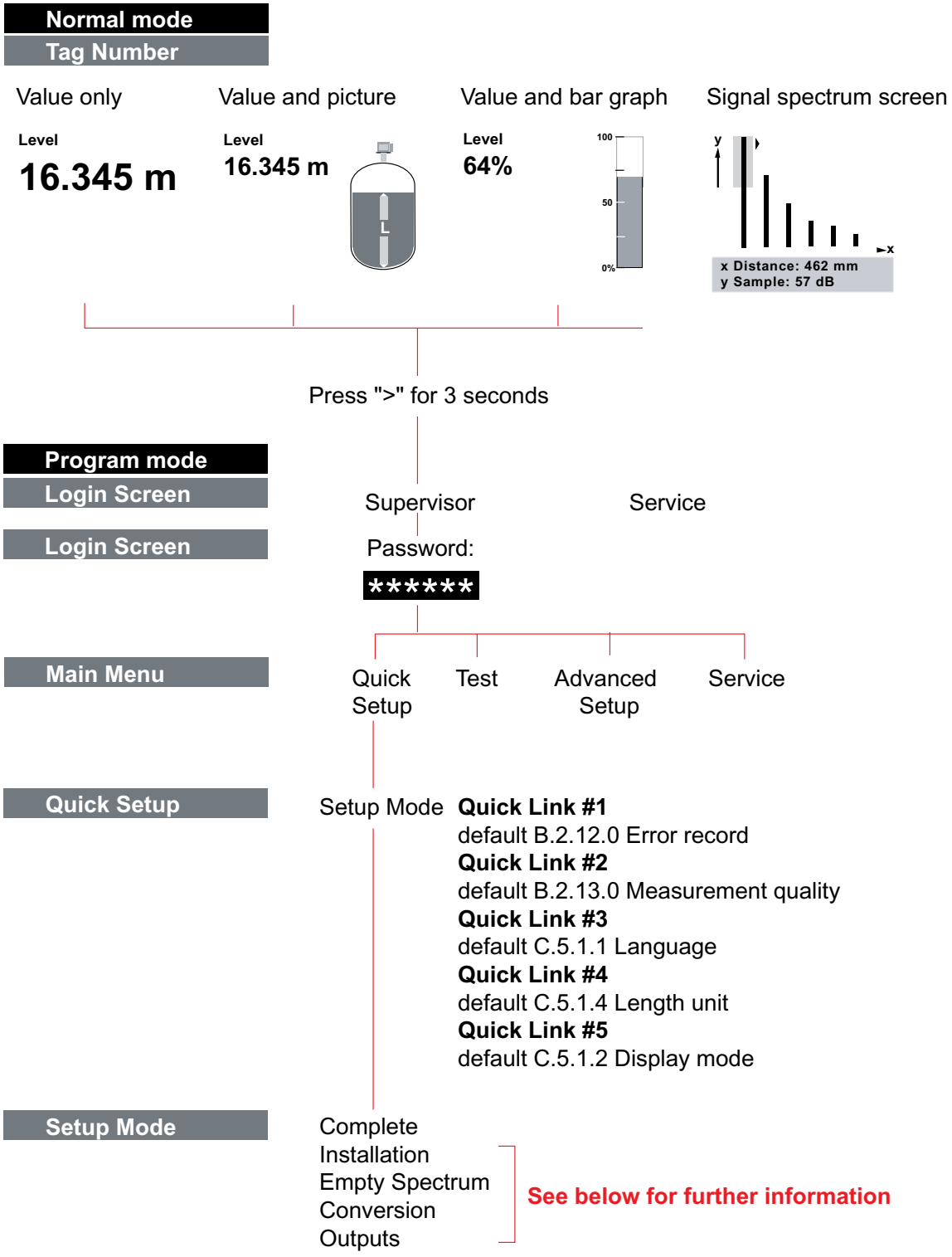
Using setup modes, the user can personalise different aspects of device operation. Setup modes available

- complete
- installation
- empty
- spectrum
- conversion
- output

These are explained using diagrams to show the flexibility of the system.

Finding setup mode

The illustration below shows how to find quick setup menus from normal mode.

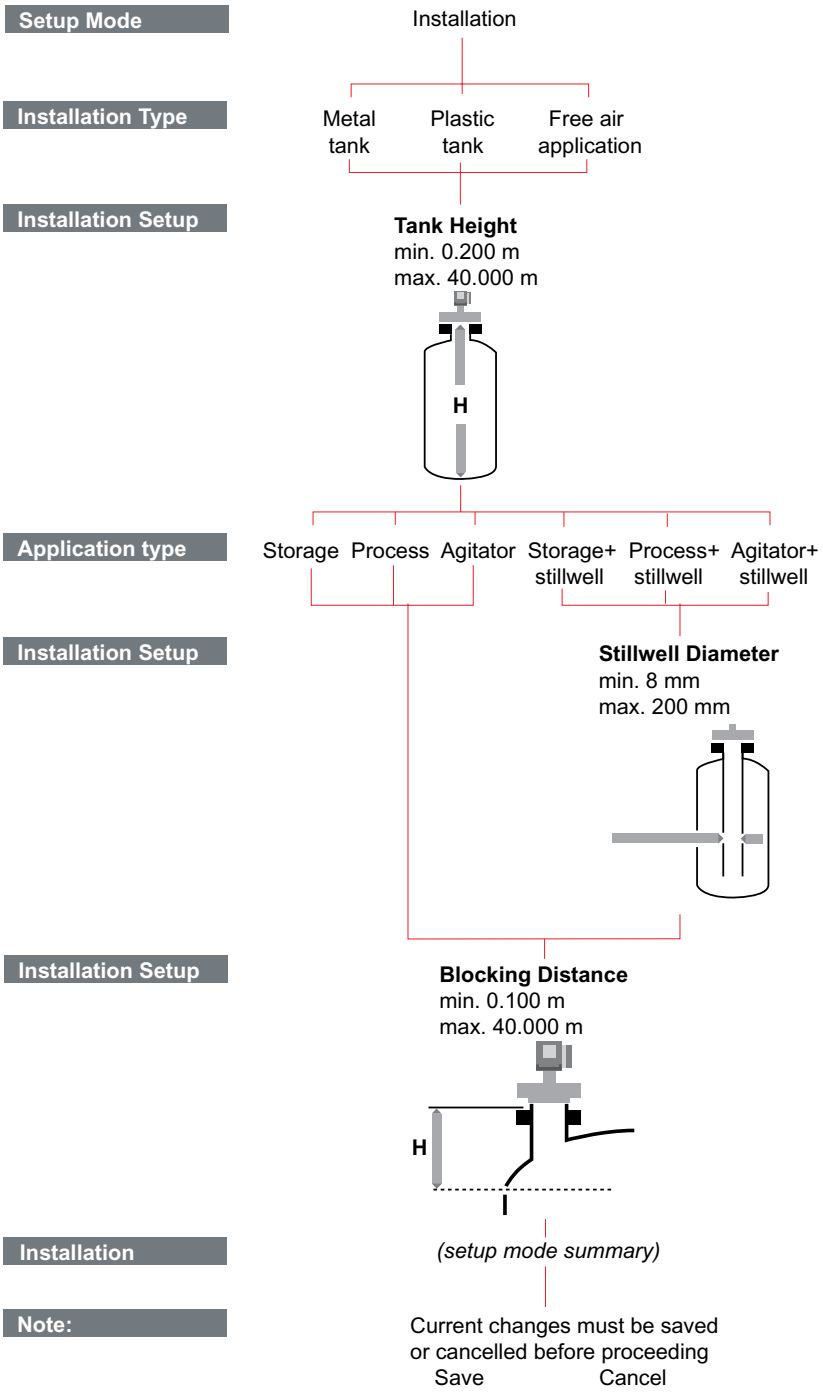


Complete setup mode

Using the complete setup mode option, you can configure all the items in installation, empty spectrum, conversion and output setup modes.

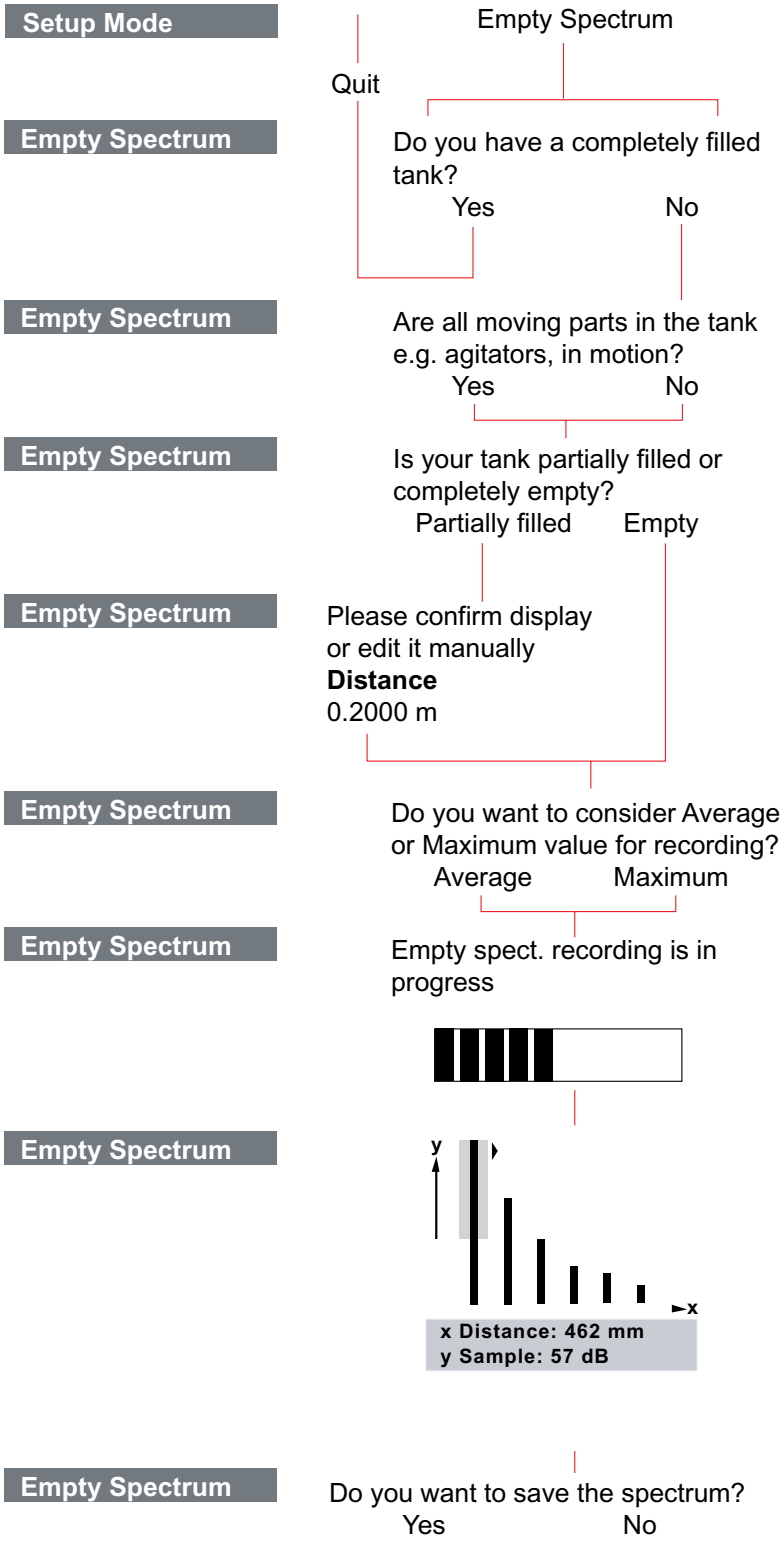
Installation setup mode

For defining tank material, process connection, tank height and product state.



Empty spectrum setup mode

For filtering out interference signals produced by fixed and moving obstacles in the tank.



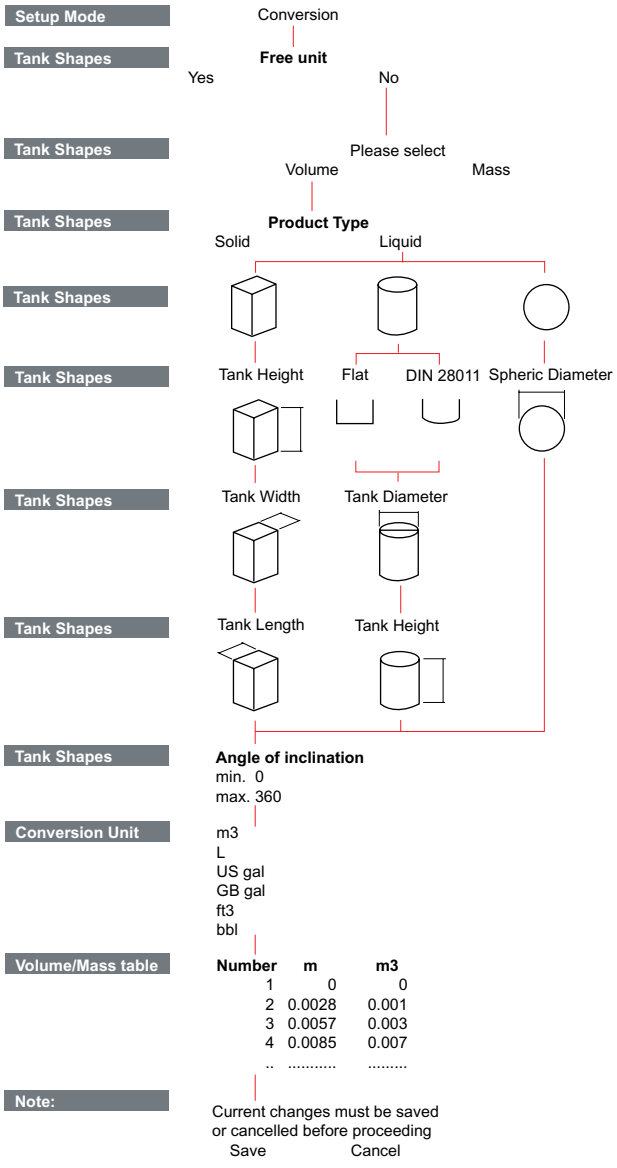
Conversion setup mode

Using a conversion table created in this setup mode, you can display measurements with volume, mass or user defined units.

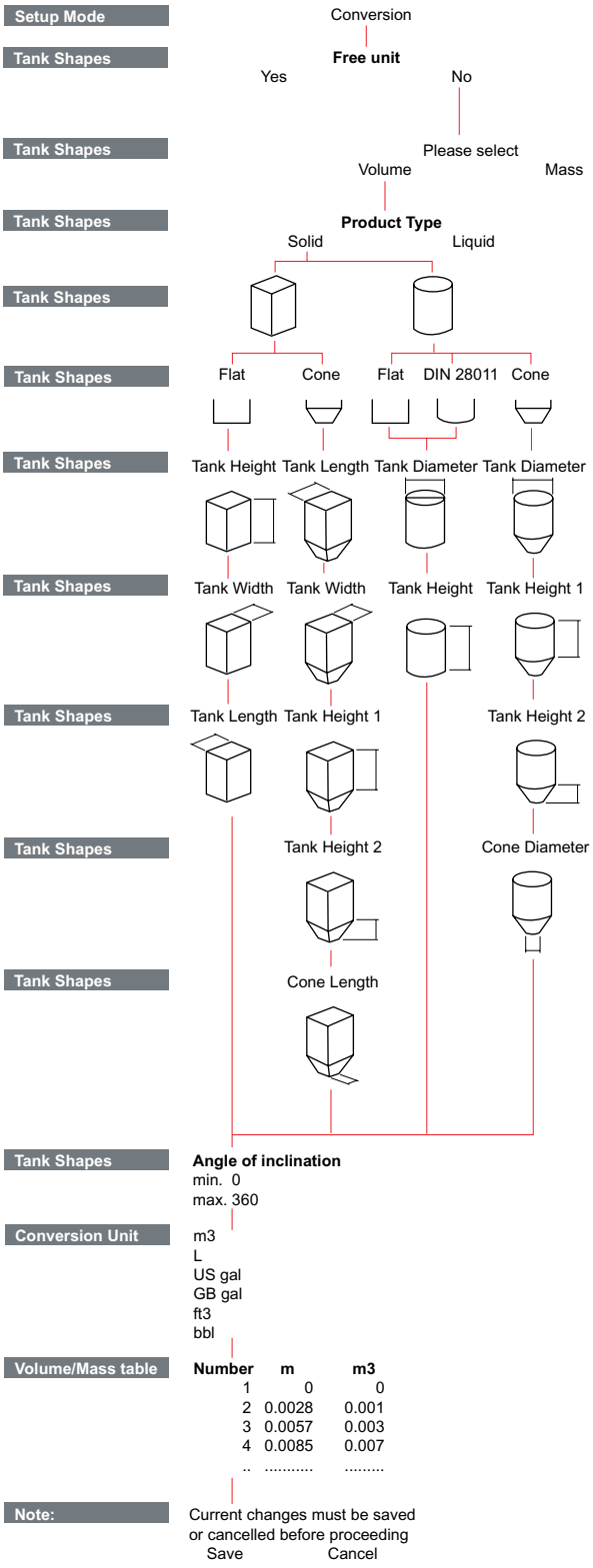
Due to the numerous possibilities available, a procedural tree diagram is shown for each of the following

1. volume measurement of liquids
2. volume measurement of solids
3. mass measurement of liquids or solids
4. measurement of user-defined length and conversion units

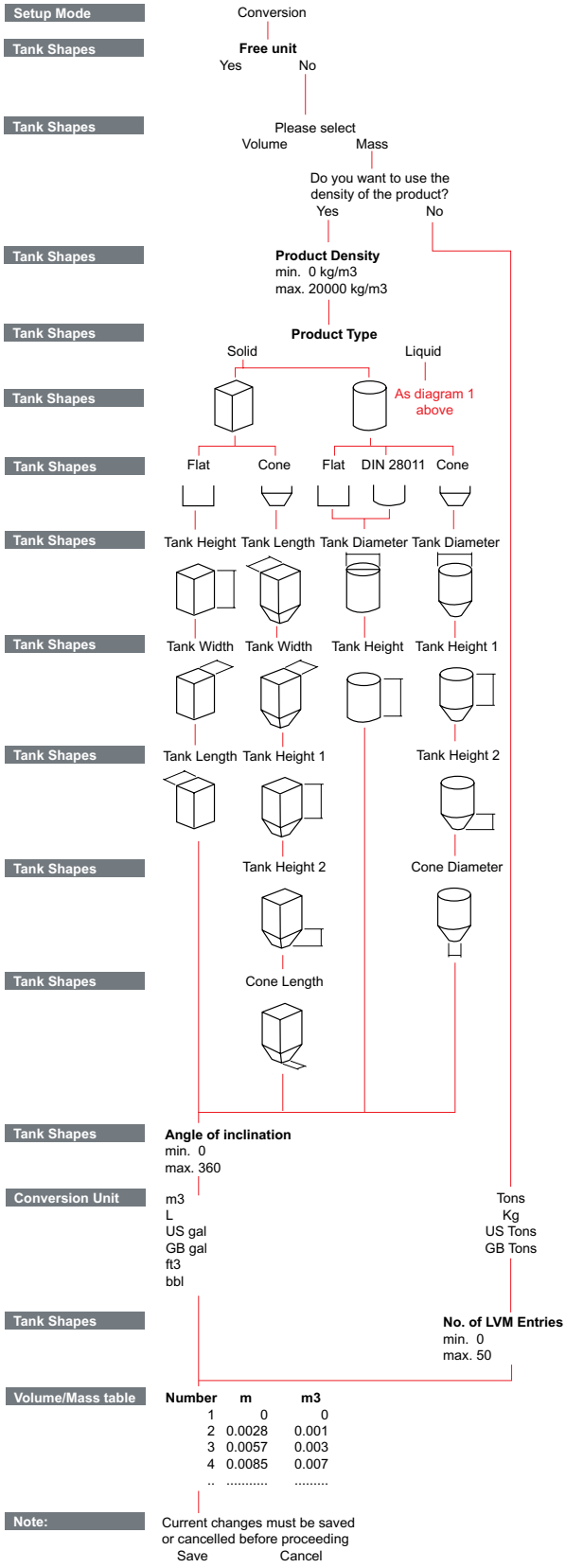
1. Volume measurement of liquids



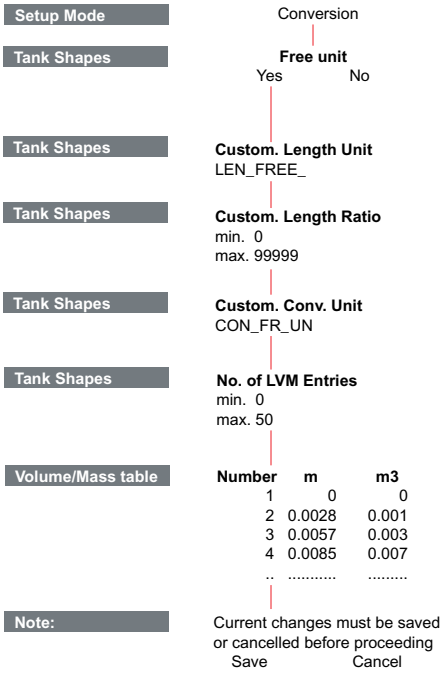
2. Volume measurement of solids



3. Mass measurement of liquids or solids



4. Measurement of user-defined length and conversion units



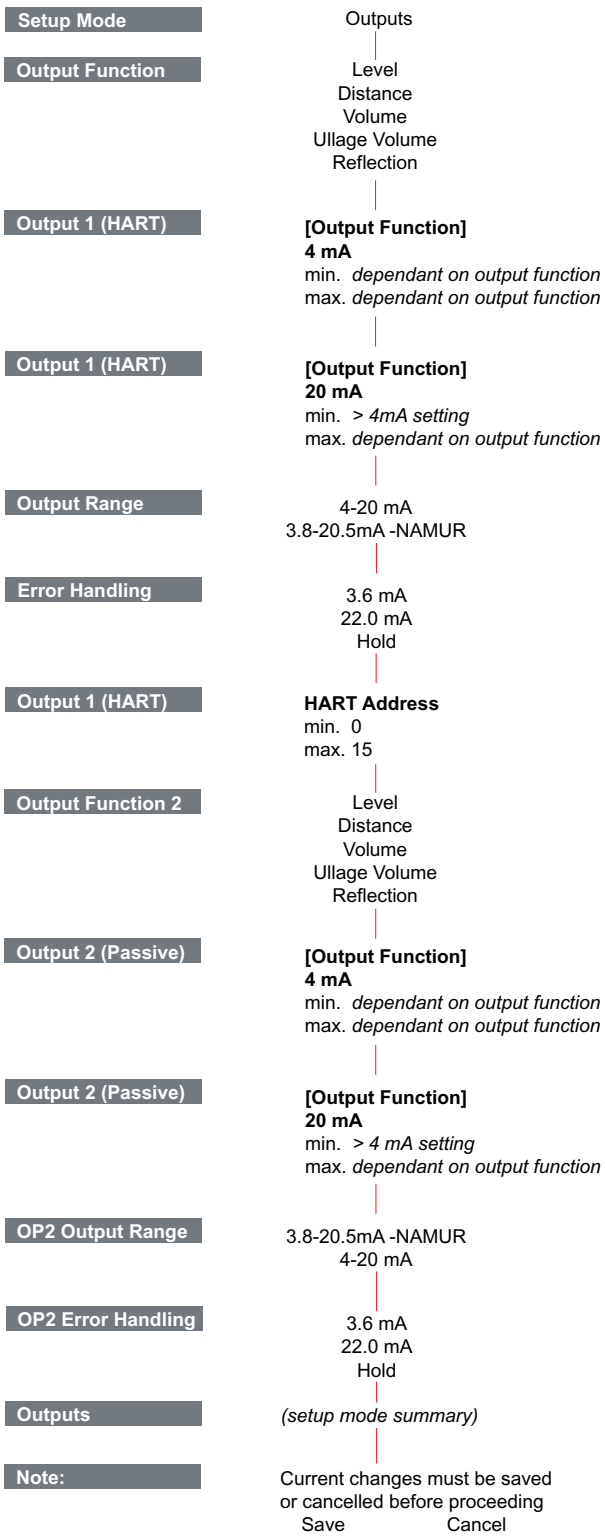
Horizontal cylindrical tanks
type in “90°” under angle of inclination. Calibrate volume as for other tanks.

No. of LVM entries
This refers to the number of lines generated for typing in level and the equivalent conversion unit (volume...) in the volume/mass table.

Free units; cutomer length ratio
Conversion factor between the basic length unit (m, ft, ...) and the new free unit. Multiply the basic length unit by this value to get the new unit.

Outputs setup mode

For defining the measurement function and range, digital network address and signal on alarm.



Displaying volume measurements

Select a volume output function.

Advanced setup menu

Using this menu, you can modify indivdual functions. These functions are grouped under

- Installation setup
- I/O
- Output 1 (HART)
- Output 2 (Passive)
- Device Setup
- Reset

Refer to section 4.2.3: Summary of user items for a description of advanced setup menu items.
Functions are explained further in section 4.2.4 Advanced setup: further notes.

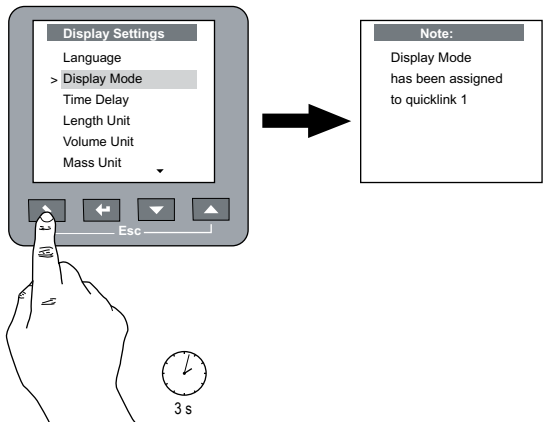
Quick links

Quickly navigate to and configure advanced setup menu items using Quick link memory spaces given in the Quick Setup submenu

Create a quick link

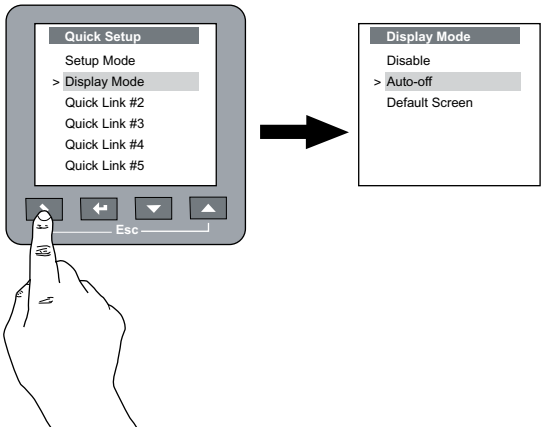
Go to the required submenu via Program mode > Advanced Setup and select the menu item you need by moving the cursor to that
item
Press the right button for three seconds. A text screen will indicate to which quick link memory space the function has been assigned.

NOTICE The quick links are assigned in chronological order: if Quick link #1 was the last link assigned, the next menu item will be saved to Quick
Link #2. Once Quick Link #5 memory space has been filled, the next quick link will be assigned to Quick Link #1 (overwriting the
previously saved item).



Using quick links

1. Select the suitable line in the Quick Setup menu
2. Press the right key to go directly to the function



4.2.3 Summary of menu items (device display Wizard)

Quick setup functions

Function (Fct.)		Input Range	Description
A.0.0.0	Quick Setup		
A.1.0.0	Setup mode		Sets up the device for common applications using pre-defined steps.
A.1.1.0	Complete	N/a. As functions in advanced setup sub-menu.	Sets up the device using all the steps given in the installation, empty spectrum, conversion and output setup modes.
A.1.2.0	Installation	N/a. As functions in advanced setup sub-menu.	Setup mode for defining the tank conditions.
A.1.3.0	Empty spectrum	N/a. As functions in advanced setup sub-menu.	Setup mode for filtering out parasite signals in the tank.
A.1.4.0	Conversion	N/a. As functions in advanced setup sub-menu.	Setup mode for creating a conversion table for displaying volume or mass measurements.
A.1.5.0	Outputs	N/a. As functions in advanced setup sub-menu.	Setup mode for defining the output characteristics.
A.2.0.0 A.3.0.0 A.4.0.0 A.5.0.0 A.6.0.0	Quick Link #1 Quick Link #2 Quick Link #3 Quick Link #4 Quick Link #5	N/a. As functions in advanced setup sub-menu. #1: B.2.12.0 Error records; #2: C.5.3.0 Measurement quality; #3: C.5.1.1 Language; #4: C.5.1.4 Display / Length unit; #5: C.5.1.2 Display / Display mode	“Quick links make it easier to find frequently-used functions.To set up a new quick link, go to the menu item you want and press the right key for 3 seconds.

Test functions

Refer to section 5.0: Functional checks.

Advanced setup functions

Function (Fct.)		Input Range	Description
C.0.0.0	Advanced setup		This menu optimizes the configuration of the device.
C.1.0.0	Installation setup		This includes parameters for installation and application conditions. Also for defining conversion operations.
C.1.1.0	Installation type	Metal tank, plastic tank or free air application. Metal tank	This defines where the device is installed. Plastic tank also refers to tanks that are made from glass and fibreglass.
C.1.2.0	Tank height or measuring range	Tank height: 0.2 m or 8” to 40 m or 131 ft. 10 m or 33 ft Measuring range: 0.5 m or 1½ ft to 40 m or 131 ft. 10 m or 33 ft	Tank height is the distance from the tank connecting flange face/ thread stop down to the tank bottom. The term “Measuring range” is used if you selected free air application as the Installation Type.
C.1.3.0	Application type	Process, storage, agitator, storage + stillwell, process + stillwell or agitator + stillwell. Process	Application conditions. “Storage” refers to a flat product surface. “Process” refers to a disturbed surface without vortex. “Agitator” refers to a disturbed surface with vortex and foam.
		No disturbance, medium disturbance or heavy disturbance. No disturbance	If you selected free air in Installation Type, then an alternative menu appears. “No disturbance” means a flat surface. “Medium” refers to a disturbed surface without vortex. “Heavy” means a bubbling surface with vortex and possibly foam.
C.1.4.0	Stillwell height	0 to 40 m or 131 ft. 10 m or 33 ft	This defines the height from the tank connecting flange face / thread stop down to the stilllwell base.
C.1.5.0	Stillwell diameter	20 mm or 0.8” to 1000 mm or 40”. 100 mm or 4”	This defines the inner diameter of the stillwell.

Advanced setup functions (Continued)

(Fct.)		Input Range	Description
C.1.6.0	Antenna extension	Tank height to max. 5000 mm or 16½ ft. 0 mm or 0 ft	Antenna extension is the distance from the flange facing / thread stop of the device down to the top face of the antenna horn.
C.1.7.0	Distance piece	0 mm or 0 ft to 5000 mm or 16½ ft. 0 mm or 0 ft	Distance from the upper side of the flange to the bottom face of the converter connection. If a different length is installed, type in the new value.
C.1.8.0	Overfill detection	Yes or no. Yes	Using this function, the level is tracked within the blocking distance but the displayed output remains fixed at the blocking distance limit. The device displays an error icon to warn the user that the tank is overfilling. It is not related to WHG.
C.1.9.0	Blocking distance	Antenna extension (C.1.6.0) to Tank height (C.1.2.0) or 5000 mm or 16½ ft. 0 mm or 0 ft	The non-measuring range below the flange facing or thread stop of the device.
C.1.10.0	Reference offset	-50 m or -164 ft to 50 m or 164 ft. 0 m or 0 ft	Offset relating to a reference location (distance). This value is positive when the reference location is above the device flange face and negative if below.
C.1.11.0	Tank bottom offset	-50 m or -164 ft to 50 m or 164 ft. 0 m or 0 ft	Offset relating to a reference location (level). The device reference point for this parameter is the bottom of the tank, related to Tank height (C.1.2.0). This value is positive when the reference location is below the tank bottom and negative if above.
C.1.12.0	Time constant	0 to 100 seconds. 10 sec	Using this function, the device processes several measurement readings to filter out disturbances. Increasing the time constant will smoothen the integrated readings, decreasing will roughen the readings.

Advanced setup functions (Continued)

(Fct.)		Input Range	Description
C.1.13.0	Measuring mode	Direct measuring, tank bottom following (TBF) partial, tank bottom following (TBF) full. Direct measuring	The device tracks level using different methods. Direct measuring is recommended where εr > 1.8, depending on tank type. For products with εr < 1.8, TBF mode is required. Partial TBF mode is only used for storage tanks with flat bottoms or with targets at the bottom of the tank. Full TBF mode is mainly used for process tanks.
C.1.14.0	Product εr	1.01 to 10. 1	Accessible when a TBF measurement mode is selected in menu item C.1.13.0. A major parameter for RADAR level measurement devices. Manually sets the εr value of the product.
C.1.15.0	Tracing velocity	0.001 m/min to 10 m/min. 0.5 m/min	Defines the maximum rate of change of level that can occur. The measured value cannot change at a faster rate than the tracing velocity.
C.1.16.0	Multiple reflections	Yes or no. No	Multiple reflections are common in storage tanks with an extremely calm surface, typically when the device is mounted on a large nozzle (manhole) or centred on a dome roof. Multiple reflections also occur when the tank has a flat or only slighty convex roof. Such multiple reflections tend to result in lower-than-actual level readings. In such cases, activate this function.
C.1.17.0	Empty spectrum On/Off	On or off. On	An empty spectrum is used to surpress interference signals produced by fixed and moving obstacles inside the tank. For this function an empty spectrum needs to be recorded first. This is done in the Quick setup menu under Empty spectrum (A.1.3.0).

Advanced setup functions (Continued)

(Fct.)		Input Range	Description
C.1.19.0	Units for tables		The device can perform volume and mass conversion operations by pairing values in a table. The units for the table columns can be picked from the lists here.
C.1.19.1	Length unit	m, cm, mm, inch, ft, ft+inch+1/18inch, ft+inch+1/32inch or free unit. m	Pick the length unit to be used in volume/mass conversion table from the list. If free unit is selected, the unit given in item C.5.1.7 is used.
C.1.19.2	Conversion unit	m^3, L, US gal, GB gal, ft^3, bbl, Tons, kg, US tons, GB tons or free unit. m^3	Pick the conversion unit to be used in the conversion table from the list. If a mass conversion unit is directly selected here, a mass conversion table will be created (volume conversion will then not be possible). If free unit is selected, the unit given in item C.5.1.9 is used.
C.1.20.0	Product density	0 to 999.99 kg/m^3. 0	A volume conversion table together with a product density greater than 0, can be used to calculate mass. If a mass conversion unit has already been directly selected, this menu is disabled.
C.1.21.0	Volume/Mass table	Level: 0 m or 0 ft to tank height (C.1.2.0)+tank bottom offset (C.1.11.0)+reference offset (C.1.10.0); volume: 0 m^3 to tank volume.; mass: 0 kg to mass of full tank.	Give number of value pairs needed. Enter the length and corresponding volume/ mass values. 50 pairs maximum.
C.1.22.0	Linearisation table	0 m or 0 ft to tank height (C.1.2.0)+tank bottom offset (C.1.11.0)+reference offset (C.1.10.0).	This function can increase accuracy via on-site calibration. Give the number of value pairs needed. Use an accurate alternative method of measurement to give a corrective value to a given measurement. 50 pairs maximum.

Advanced setup functions (Continued)

(Fct.)		Input Range	Description
C.2.0.0	I/O		
C.3.0.0	Output 1(HART)		Defines characteristics of output 1.
C.3.1.0	Output function	Level, distance, level volume/mass, reflection, distance volume/mass.Level	Pick the output function from the list. This is independent of the measurement function being displayed.
C.3.2.0	4 mA setting	-50m/0m³/0kg to 20 mA setting (item C.3.3.0) of output parameter (item C.3.1.0) selected. 0 m/m³/kg	This assigns a measurement value to 4 mA
C.3.3.0	20 mA setting	4 mA setting (item C.3.2.0) of output parameter (item C.3.1.0) selected to value dependant on output function. **	This assigns a measurement value to 20 mA
C.3.4.0	Output Range	3.8-20.5 mA-NAMUR or 4-20 mA. 3.8-20.5 mA-NAMUR	This defines the behaviour of the output 1 in case an error occurs. It sets the effective range of current output with or without over-run.
C.3.5.0	Error handling	3.6 mA, 22 mA or Hold. 22 mA	Defines the behaviour of the current output in case an error occurs.
C.3.6.0	HART address	0 to 15. 0	Any HART address greater than 0 will enable HART Multidrop mode (current output fixed at 4mA).
C.5.0.0	Device setup		You will find the complete list of menu items relating to the setup of the device display screen here. This includes parameters for protecting settings and measurement value formats.
C.5.1.0	Display settings		Sets device display characteristics.

Advanced setup functions (Continued)

(Fct.)		Input Range	Description
C.5.1.1	Language	American edition: English, French, Spanish or Portuguese; European edition: English, German, French, Spanish, Portuguese or Italian; Asian edition: English, Japanese, Mandarin, Russian. English	Sets the language for readings and configuration.
C.5.1.2	Display mode	Disable, Auto-off or default screen. -	Defines the status of the display after a given time delay. 'None' disables this functionality, 'Auto-off' switches off the display and 'Default screen' will show the selected default screen. The default screen can be selected in Normal mode by pressing the down button for three seconds.
C.5.1.3	Time delay	1, 3, 5 or 10 minutes. 3	Determines the time after which the display will switch to the status set in C.5.1.2 Display mode.
C.5.1.4	Length unit	m, cm, mm, inch, ft, ft+inch+1/18inch, ft+inch+1/32inch or free unit. m	Displayed length unit in normal mode.
C.5.1.5	Volume unit	m^3, L, US gal, GB gal, ft^3 or bbl. m^3	Displayed volume unit in normal mode.
C.5.1.6	Mass unit	Tons, kg, US tons or GB tons. kg	Displayed mass unit in normal mode.
C.5.1.7	Customer length unit	9 characters max. Drexelbrook	Customer-defined length unit to be displayed.
C.5.1.8	Customer length ratio	1 to 99999. 1	Enter the factor between C.5.1.4 Length unit selected and C.5.1.7 Customer length unit. Relative to 1 m
C.5.1.9	Customer conversion unit	9 characters max. -	A customer-defined conversion unit for display/conversion table.
C.5.2.0	Passwords		

Advanced setup functions (Continued)

(Fct.)		Input Range	Description
C.5.2.1	Supervisor password - Enable/ disable	Enable or disable. Enable	Activates or deactivates device configuration protection (for all functions listed in this section)
C5.2.2	Supervisor	6 characters max.using kepad right(R), enter(E), down(D) or up (U). REDURE	Modifies the supervisor password. To confirm the change, the new password must be entered twice.
C.5.2.3	Service	6 characters max.using kepad right(R), enter(E), down(D) or up (U).	Modifies the service password. To confirm the change, the new password must be entered twice.
C.6.0.0	Reset		
C.6.1.0	Factory Reset	Confirm to reset.	Resets all parameters to their factory defaults. Device settings before the reset will be lost. Service personnel only.
C.6.2.0	Customer Reset	Confirm to reset.	Resets parameters for all functions listed in this section to their factory defaults. Device settings before the reset will be lost.
C.6.3.0	Restart	Confirm to reset.	If the device is not functioning properly, this will restart the device.

4.2.4 Advanced setup: further notes

General notes

The menu items listed below may only be re-configured by a user with supervisor rights.

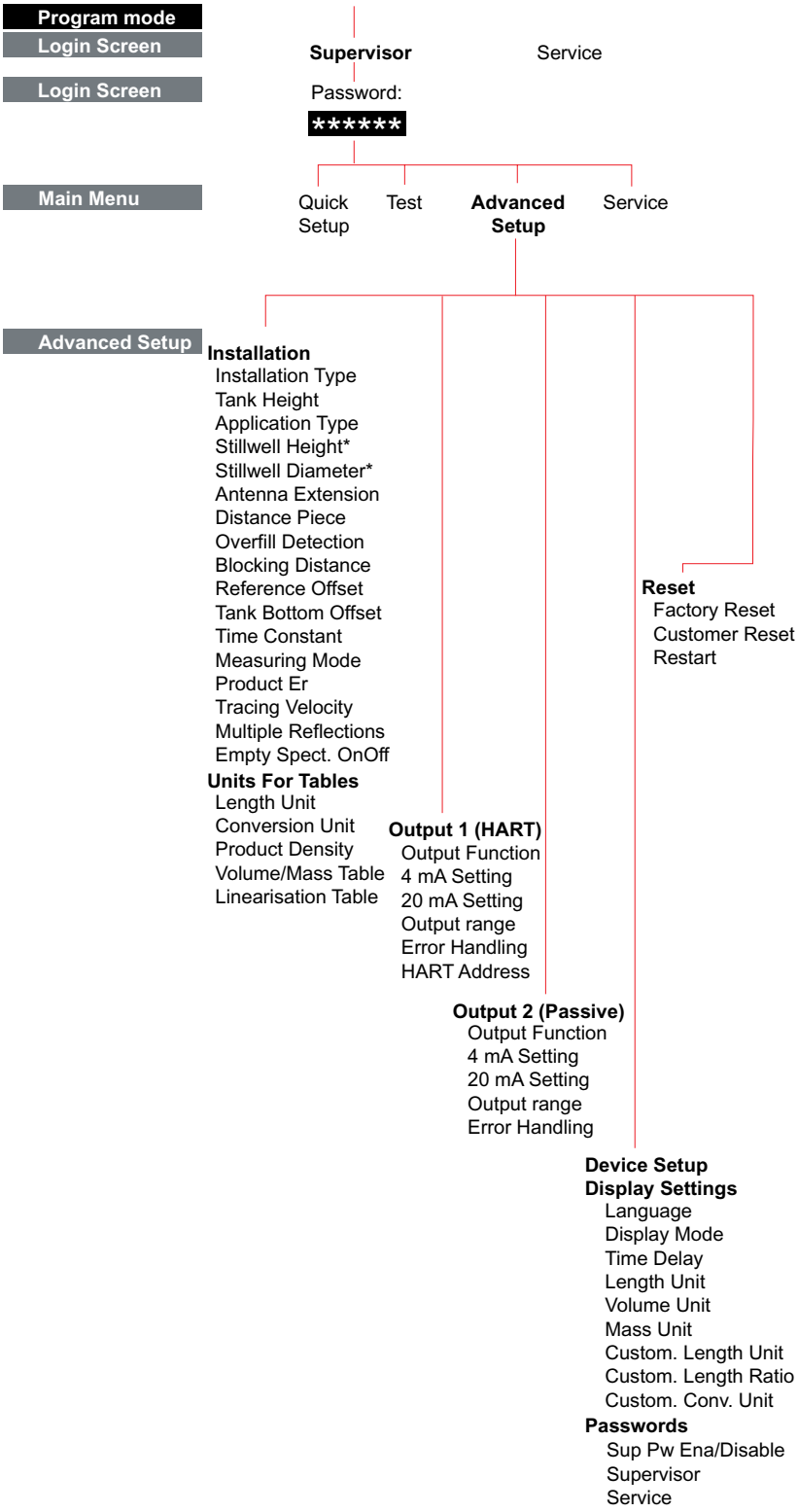
Using the advanced setup menu, you can

- change the parameters for one or more functions without going through a quick setup procedure
- use individual menu items to manually override automatic settingq assigned during quick setup procedures

Critical parameters

Risk of measurement error

Finding the advanced setup menu



* Can be configured if “Storage+Stillwell”, “Process+Stillwell” or “Agitator+Stillwell” is selected in Application Type menu item

How to protect your gauge settings

Protect your settings by following this path to the Passwords menu

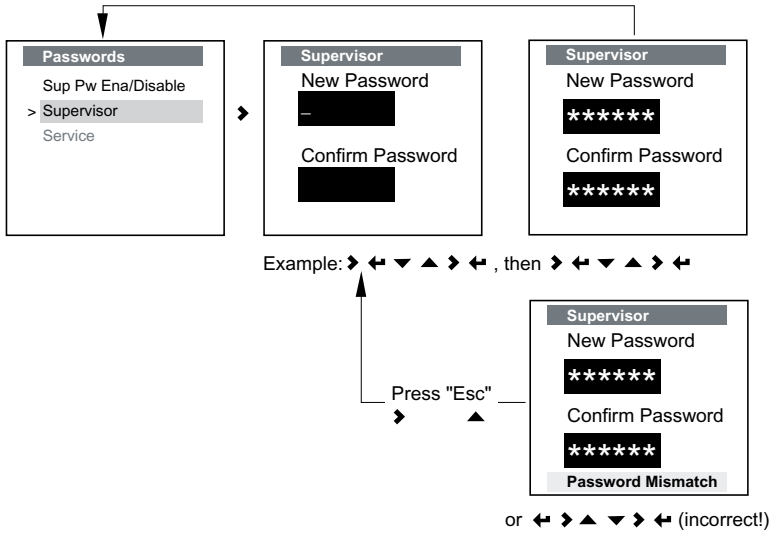
Advanced Setup > Device Setup > Passwords

Using this menu, you can

- switch on or off restricted access to program mode for which a supervisor password is needed. If switched off, all users will be able to display device information and change quick setup and advanced setup settings.
- change the supervisor password

Changing the supervisor password

1. From the Advanced Setup menu, select the Device Setup submenu, then Supervisor.
2. Type the new password (six characters using any of the four keys below the screen) then retype it to confirm. If the second set of characters is not the same as the first, the device will display the error. Press “escape” to reset and repeat step 2.
3. The screen will return automatically to the Password submenu.

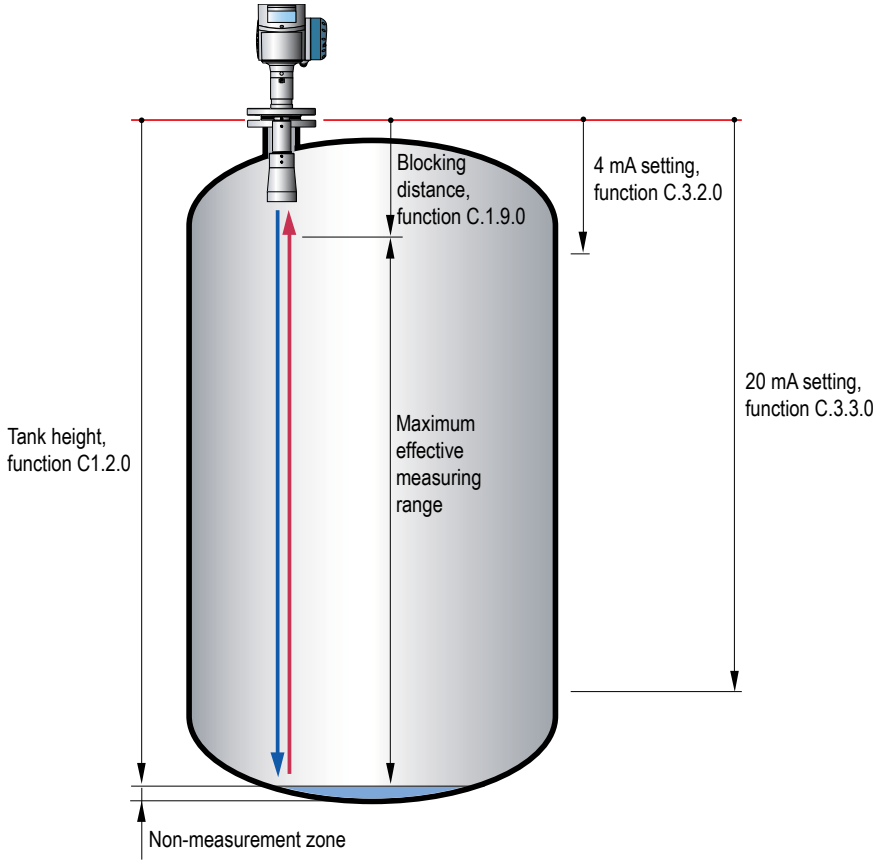


Distance measurement

Distance measurement depends on a number of factors, covered in the menu items below

- tank height
- blocking distance
- reference offset

These will influence the effective measuring range of a TDR level meter and the point from which measurements are taken.


Blocking distance, function C.1.9.0
4 mA setting, function C.3.2.0
20 mA setting, function C.3.3.0
Tank height, function C1.2.0
Maximum effective measuring range
Non-measurement zone

Tank height

function C.1.2.0

The height of the tank from the top of the tank process connection facing to the tank bottom. If not indicated in the order, this is set at the factory to probe length.

Blocking distance

function C.1.9.0

Refer to section 7.1.2: Technical data, blocking distance for the minimum recommended value for a given probe type. This prevents the device from displaying measurements within this distance to the flange and avoids confusion with parasite signals near to the flange.

Reference offset

function C.1.10.0

Configure the device to measure the distance to the product surface using a reference point other than the default flange facing.
Move the reference point above the flange facing by typing in a positive value.
Move the reference point below the flange facing by typing in a negative value.

Scaling the current output

The current output setup mode is used to create current output scales for the first and second (if ordered) outputs that meet your requirements. You must define:

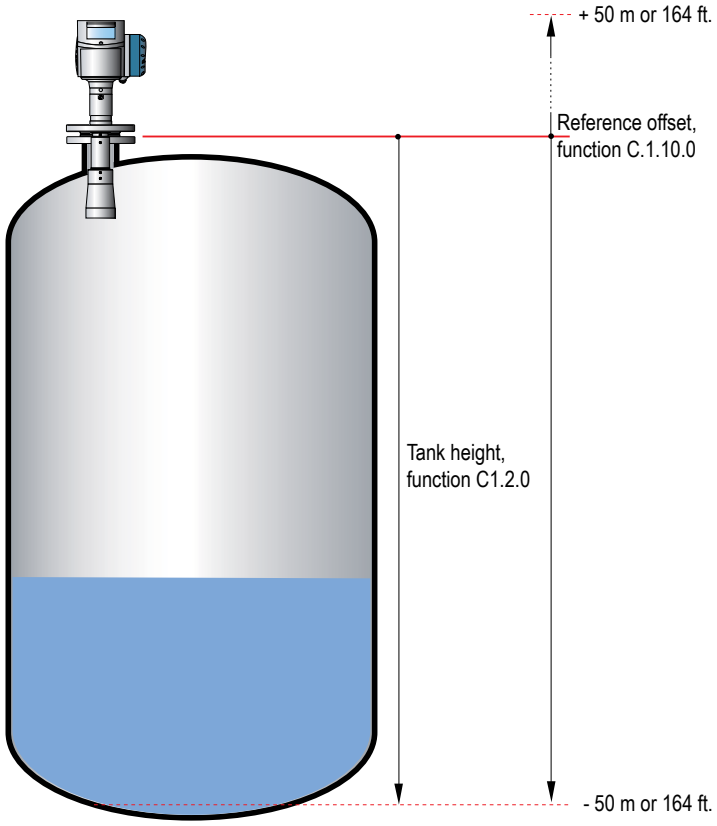
1. Output function
   function C.3.1.0 (output 1-distance)
   function C.4.1.0 (output 2-volume)

2. 4 mA setting
   function C.3.2.0 (output 1)
   function C.4.2.0 (output 2)

3. 20 mA setting
   function C.3.3.0 (output 1)
   function C.4.3.0 (output 2)

4 and 20 mA settings are defined in terms of distance from the flange facing or reference offset. These are the minimum and maximum points of your measuring scale.

Using the optional second output, you can set up a separate scale for displaying another measurement function (volume...)


+ 50 m or 164 ft.
Reference offset,
function C.1.10.0
Tank height,
function C1.2.0
- 50 m or 164 ft.

Risk of measurement error

In order to have the full current output range, do not set 4 mA setting within the device's blocking distance

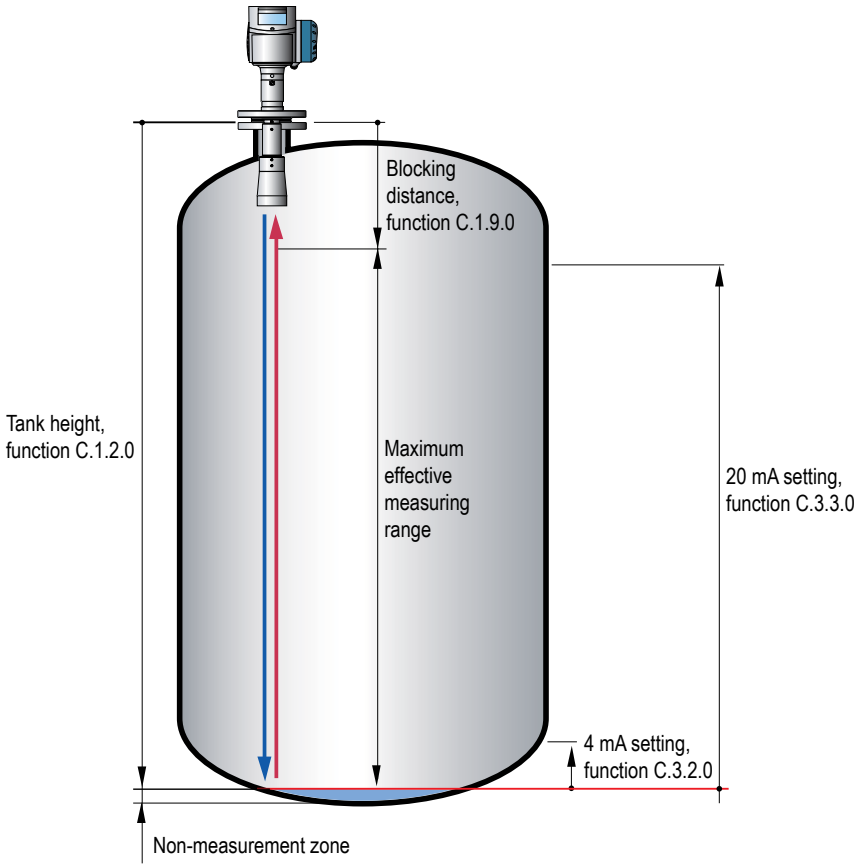
Level measurement

As for distance measurement above, level is influenced by

- tank height
- blocking distance

The reference point from which it is measured can be moved using

- tank bottom offset


Blocking distance, function C.1.9.0
Tank height, function C.1.2.0
Maximum effective measuring range
20 mA setting, function C.3.3.0
4 mA setting, function C.3.2.0
Non-measurement zone

Tank height

function C.1.2.0

Level is derived from distance and tank height (tank height - distance).

Note that when the tank has a curved tank bottom, the radar waves will reflect off the point directly below the device. A small non-measureable zone is sometimes present (see diagram below). Set the tank height above this zone: this has the advantage of setting the zero reference for level measurement above the non-measurement zone to effectively ignore it.

Blocking distance

function C.1.9.0

As for distance measurement above.

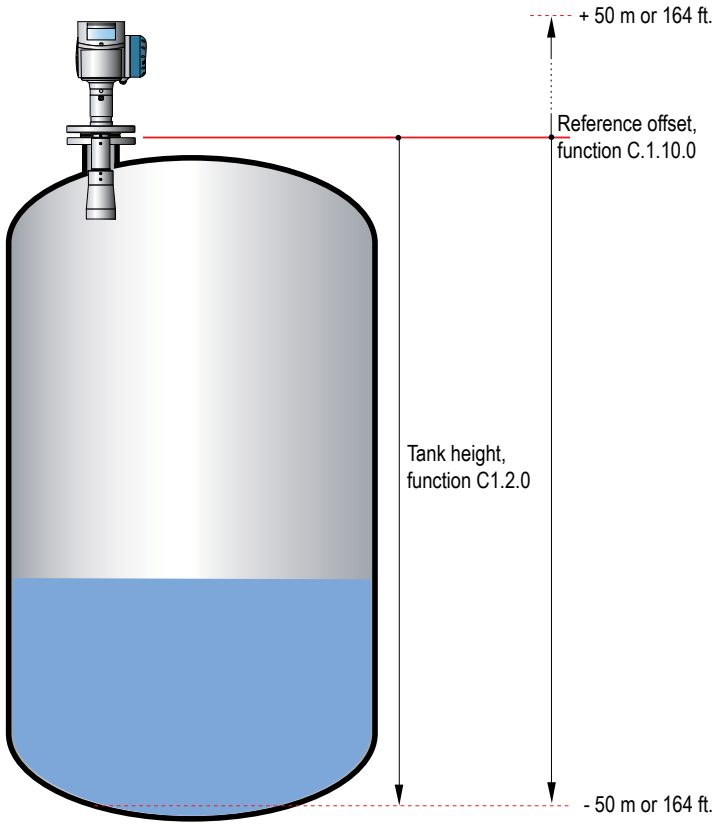
Tank bottom offset

function C.1.11.0

Configure the device to measure product level using a reference point other than the configured tank height (position of tank bottom in relation to the tank flange).

Move the reference point below the tank bottom by typing in a positive value (up to 50 m or 164 ft below). Move the reference point above the default zero by typing in a negative value.

As an example, you could set the device to measure level in terms of height above sea level.



Scaling the current output

The current output setup mode is used to create current output scales for the first and second (if ordered) outputs that meet your requirements. You must define:

1. Output function
   function C.3.1.0 (output 1-level)
   function C.4.1.0 (output 2-other: volume)

2. 4 mA setting
   function C.3.2.0 (output 1)
   function C.4.2.0 (output 2)

3. 20 mA setting
   function C.3.3.0 (output 1)
   function C.4.3.0 (output 2)

4 and 20 mA settings are defined in terms of distance from the tank bottom or tank bottom offset. These are the minimum and maximum points of your measuring scale.

Using the optional second output, you can set up a separate scale.

Risk of measurement error

In order to have the full current output range, do not set 20 mA setting within the device's blocking distance

Volume or mass measurement

Volume/Mass table
function C.1.21.0

Other relevant menu items are

Length unit [for table]
function C.1.19.1

Conversion unit [for table]
function C.1.19.2

Length unit [display]
function C.5.1.4.

Volume unit [display]
function C.5.1.5

Mass unit [display]
function C.5.1.6

Custom. length unit [display]
function C.5.1.7

Custom. length ratio [display]
function C.5.1.8

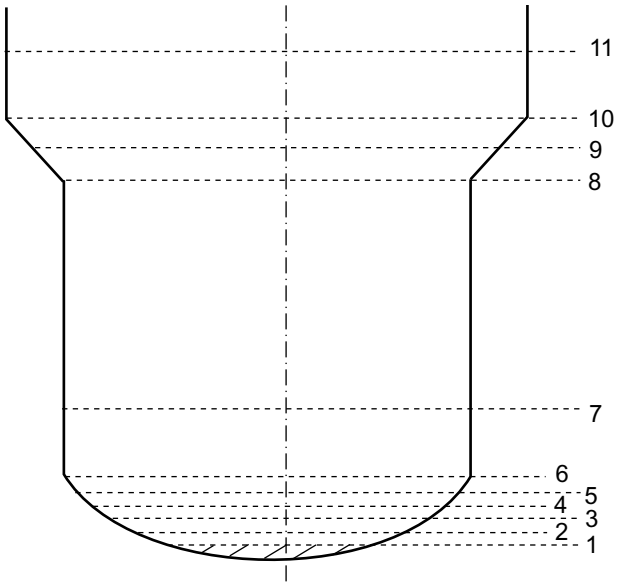
Custom. conv. unit [display]
function C.5.1.9

You can define your own length and conversion units with the last three functions.
When configuring the device to measure volume, we recommend that you use the conversion setup mode: all relevant parameters are covered.

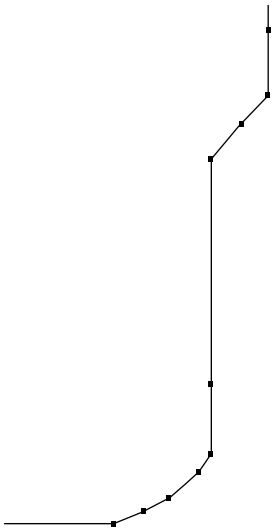
You can type in up to 50 value pairs (level-volume, level-mass or level-free unit).

NOTICE

- Level should be taken from the bottom of the device's measuring range (tank height).
- Concentrate points in areas where there are curved surfaces or abrupt changes in cross-sectional area (see example in the diagram and table below) - this will improve measurement accuracy.



Tank



Tank model
using plotted points

Low-dielectric non-standard products: how to measure them correctly

As described in section 8: Measuring principle, the device can measure low dielectric products. However, certain situations such as

- build-up on the antenna and nozzle
- products that do not correspond to preset conditions available in the quick setup menus
- parasite signals from unavoidable nearby obstructions in the tank can affect device performance.

You can use the following menu items to regulate the device's ability to track product level

- Measuring mode
- Product εr
- Multiple Reflections
- Empty Spectrum On/Off
- Signal screen editing mode [distance of target signal]

Measuring mode

function 1.13.0

Using this function, you can define a mode for measuring the product that is adapted to its properties (dielectric constant). For further information regarding the measuring principle, please refer to Section 8: Measuring principle.

Three modes are possible:

- **Direct**: direct measurement of the surface of the product
- **Full TBF**: TBF is activated over the total measuring range i.e. tank height. In order to reduce inaccuracies, type in an exact value of dielectric constant in function C1.14.0 Product εr. Recommended for process tanks.
- **Partial TBF**: TBF mode is only active near to the tank bottom i.e. 20% of tank height but not less than 0.6 m. If filled above 20% capacity, the measurement mode will switch automatically to direct mode (using the reflection from the product surface). In order to reduce inaccuracies, enter an exact value of dielectric constant in function C1.14.0 Product εr. Recommended for storage tanks with flat bottoms.

Product εr

function C.1.14.0

For low dielectric constant products and when using TBF mode only. Type in an exact value for dielectric constant, εr.

If the product's dielectric constant is not known, then leave at the default value of 2. However, in this case expect reduced accuracy and/or skipping of the measured value when the measuring mode switches over from TBF to direct mode (for example, if εr is set lower than the real value then the indicated level will be higher than it actually is and vice versa).

Empty spectrum on/off

function C.1.17.0

Fixed and moving internals in the tank produce interference signals (false reflections) that can result in incorrect measurements.
Empty spectrum configuration, provided as a quick setup mode, permits interference signals to be identified and blanked out, by recording these signals before tank filling and process startup.

The tank should ideally be completely empty and all moving parts switched on.
Follow the instructions as given in the device display
Wizard.
Empty spectrum filtering is not required if no interference from the tank is expected.

On-site device calibration

Linearisation table

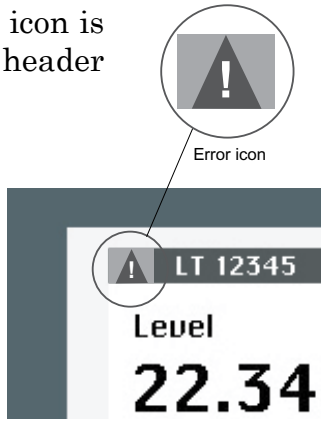
function C.1.22.0
For on-site calibration.

Linearisation procedure

1. Fill the tank to any given level.
2. Go to the linearisation table menu item via advanced setup > installation. The level reading will be displayed with the possibility to enter a different value
3. Make an appropriate reference measurement.
4. Type in the corrected value and confirm
5. Repeat procedure (50 points maximum).

4.3 Error messages and troubleshooting (device display Wizard)

When the device detects a problem, an error icon is shown at the top left of the display screen's header bar. The error is logged in the instrument.

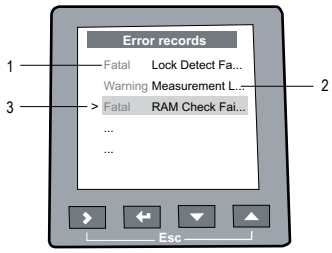


How to troubleshoot errors

Go to menu item B.2.6.0 Error records in program mode to read find out which errors have been logged

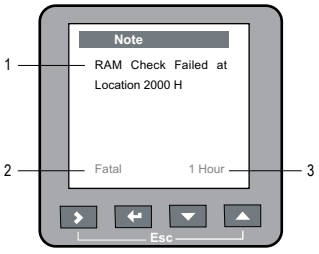
Program mode > Test > Error records

1. Scroll through the error list using the up and down buttons to select the error log you want. Five errors are listed per page - scroll down the list to view other pages.



1. Type of error
2. Brief description of error
3. Selection bar

2. Scroll to the error log you want and press the enter button to view details. For example



1. Full error description
2. Type of error (Fatal or Warning)
3. Time since error occurred

The time since the error occurred (see item 3 above) will not include any period of time when the device has been switched off.
The Normal Mode error alert icon disappears once you open the error record.

List of possible errors

Two types of errors are logged

1. Fatal (F): the measured value may not be correct.
2. Warning (W): the measured value is correct but may no longer be if the problem persists.

This is a complete list of error messages and corrective action you can take

Error Message	Type of Error	Description	Corrective action
Current Output			
Upper current output has saturated	W	The output has reached maximum output value (20mA or 20.5mA depending on value configured in “output range”) because the measured value is now out of range.	Return the product level to the configured range.
Lower current output has saturated	W	The output has reached minimum output value (4 mA or 3.8 mA depending on value configured in “output range”) because the measured value is now out of range.	Return the product level to the configured range.
External Influences			
Temperature is out of range for NAND Flash (bitmap image and factory setting memory)	F	The ambient temperature is outside the specified range. This may result in loss or corruption of data.	Switch off the device until the ambient temperature is back in the specified range, then switch it back on. If problem persists, contact the supplier.
Temperature is out of range for NVS (non-volatile storage for user device settings)	F	The ambient temperature is outside the specified range. This may result in loss or corruption of device settings.	Switch the device off until the temperature is within ambient range, then switch it back on. If problem persists, contact the supplier.
Self Test Manager			
Self test has failed	F	Device self-test failed.	
		Contact the supplier.	

Measuring Status			
Measurement is Old	W	Temporary error message. Time limit to get valid measurement elapsed. Present displayed measurement is no longer valid.	
		If the problem persists, “Signal down” will be displayed.	
Signal down	F	Time limit to get valid measurement elapsed.	Check tank installation for objects causing parasite signals. If necessary, contact the supplier.
Level has reached above the block distance (Tank overfill)	W	Product Level is above the block distance limit. Danger of product overflowing and/or immersing the device.	Lower the product level below the blocking distance.
Measurement is lost in the tank bottom	W	Last valid measurement was taken near to the tank bottom but the signal has now been lost. Common in tanks with dished bottom (DIN28011 or similar). The tank bottom measurement will be displayed.	The tank may be empty. The measurement status will return to normal once the tank is filled.
Measurement was terminated	W	Insufficient power to the device: the device stops measuring during the measurement cycle. It goes into low-power mode.	If the problem persists, contact the supplier.
Electronics Failures			
Microwave check failed	F	Microwave board check failed.	If the problem persists contact
Peripheral Failure	F	Hardware peripheral devices of DSP board failed.	If the problem persists contact supplier.

Peak And Spectrum Status			
Spectrum Quality is Bad	W	The quality of the spectrum is poor. Temporary display will not affect the performance of the device. If this message is continuously displayed, the measured values may be inaccurate and/or the error message “Measurement is old” will then be displayed.	Check tank installation and process. If necessary contact the supplier.
		Possible problems can be foam, vortices, turbulent product surface and internal tank elements.	
Empty spectrum is invalid	W	The Empty Spectrum stored in the device is not valid. The default or previously configured data is not the for the application in question, for instance where tank height has changed.	A new Empty Spectrum needs to be recorded for the application. Please go to Empty Spectrum Setup Mode to perform this operation.
		Empty spectrum is not used by the device while this error message is displayed.	
Plausible Peak is not available	W	Signal peak is not found within the measuring window that sorts the signals returning to the antenna. The device will automatically increase this window to find a valid signal. If the signal is not found “Signal down” is displayed.	
Software Error			
Unable to load DSP firmware	F	The download of DSP Firmware to DSP board failed.	Restart the device and if the problem persists, contact the supplier.

5.0 Functional checks

Using the device menu Program mode > Test, you can check the device outputs and perform common tests. You can display output values or assign test values in milliamperes to the outputs. In addition, internal test routines can be run.

Function (Fct.)		Input Range	Description
B.0.0.0	**Test**		
B.1.0.0	**Test**		**This checks the device outputs and performs common device tests.**
B.1.1.0	Show output 1	Read only.	This displays analogue output 1 value [mA].
B.1.2.0	Set output 1	3.6, 4, 6, 8, 10, 12, 14, 16, 18, 20 or 22 mA. **4 mA**	This sets analogue output 1 to a test value [mA] selected from a list. Output will change to selected value, independent of measurement value.
B.1.3.0	Show output 2	Read only.	This displays analogue output 2 value [mA].
B.1.4.0	Set output 2	3.6, 4, 6, 8, 10, 12, 14, 16, 18, 20 or 22 mA. **4 mA**	This sets analogue output 2 to a test value [mA] from a list. Output will change to selected value, independent of measurement value.
B.1.5.0	Internal test	Read only.	This initiates the hardware test. The device displays the results.
B.2.0.0	**Information**		**A summary of information relating to the device.**
B.2.1.0	Outputs	Read only.	This displays analogue output settings including assigned functions, error handling, 4 … 20 mA scale settings and HART parameters.
B.2.2.0	15 min. log	Read only.	This displays a log of output values for the last 15 minutes. A log is taken every 10 seconds and displayed as a graph.
B.2.3.0	Device I.D.	Read only.	This displays device order no,V-no, service no, firmware 1 version, firmware 2 version, firmware 3 version and Ex approval details.
B.2.4.0	Quick setup summary	Read only.	A summary of the parameters entered in the Quick setup menu is displayed using this item.
B.2.5.0	TAG number	9 characters max. **Drexelbrook**	The TAG number can be seen and updated here

B.2.6.0	Error records	Read only. See description.	This displays a log of instrument errors. Scroll down the list and press **enter** to display error details. Opening a log will remove the normal mode error icon if it has been displayed.
B.2.7.0	Measurement Quality	Read only.	This displays continuously changing current measurement status.
B.2.8.0	Custom. length unit	Read only.	This displays length unit name defined by the customer for conversion in menu item C.5.1.7
B.2.9.0	Custom. conv. unit	Read only.	This displays conversion unit name defined by the customerin menu item C.5.1.9.

6.0 Service and maintenance

6.1 General notes

Maintenance is normally not required in standard applications. However, heavy deposits on the probe may cause measurement deviations or faulty operation.

Warranty statement

Servicing by the customer is limited by warranty to

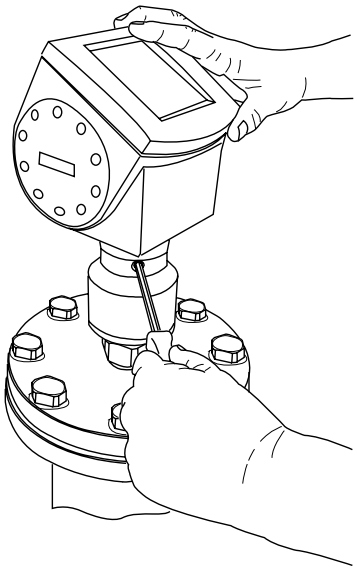
- removal and replacement of the housing containing the potted signal converter. Can be detached from the flange system under process conditions. Refer to section 6.2.

- modifying the antenna extension length. This must be done in atmospheric conditions and outside hazardous areas. Refer to section 6.3.

Other repairs must be done by Drexelbrook-authorized service staff.

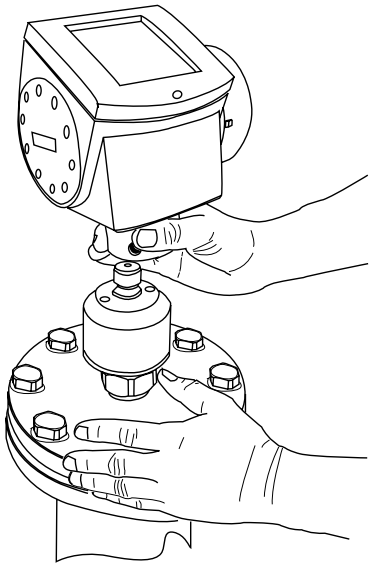
6.2 Signal converter replacement Procedure

Do not loosen flange bolts
Disconnect the device from the power supply



1. Disconnect all wires
   (refer also to Section 2.1.2: Wiring procedure).

2. Unscrew M10 socket head set screw on the housing support pillar with a 5 mm hexagon key.



3. Remove the housing by sliding it up and off the adaptor collar pin.

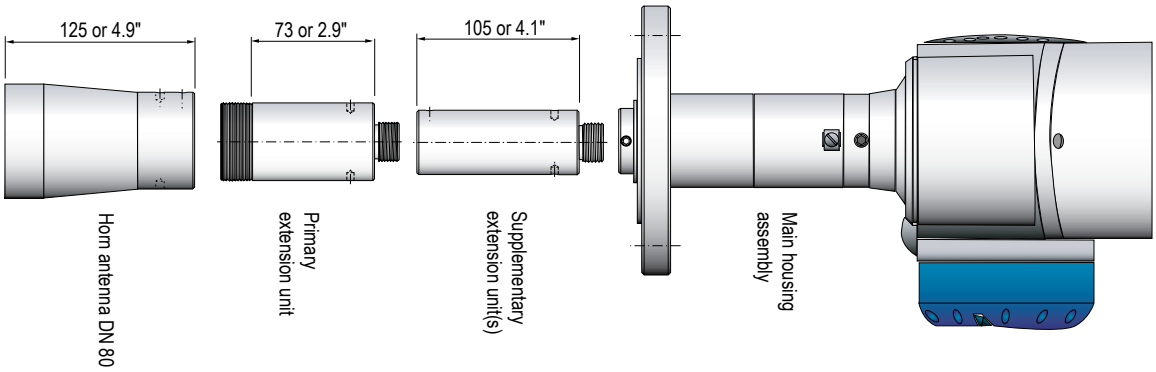
4. Remount the signal converter using the same procedure.

Equipment in hazardous areas

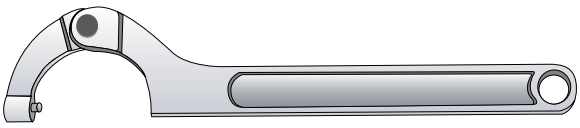
Before replacing the signal converter in hazardous locations, make absolutely sure that there is no risk of explosion (gas-free certificate). For further information refer to the approval certificate and the special manual for devices approved for use in the potentially explosive atmospheres.

6.3 Modifying antenna extension length

Modular DN 80 horn antennas may be lengthened or shortened by adding or removing antenna extension units.

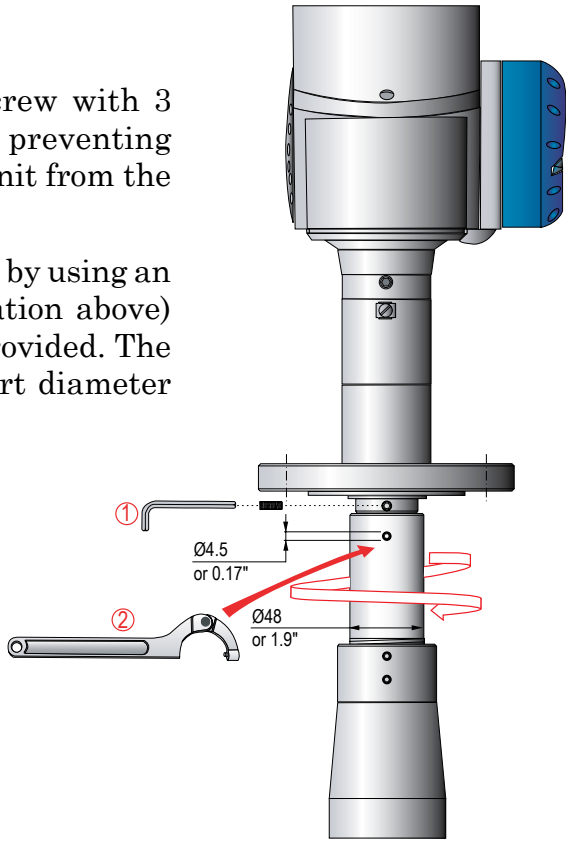


An adjustable pin wrench for the part diameters given below is required for loosening and tightening the elements. Adjustable pin wrench



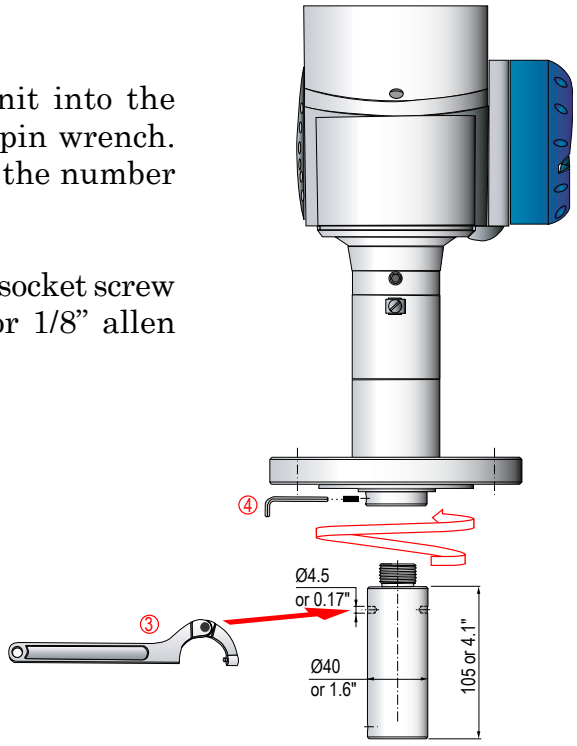
Procedure

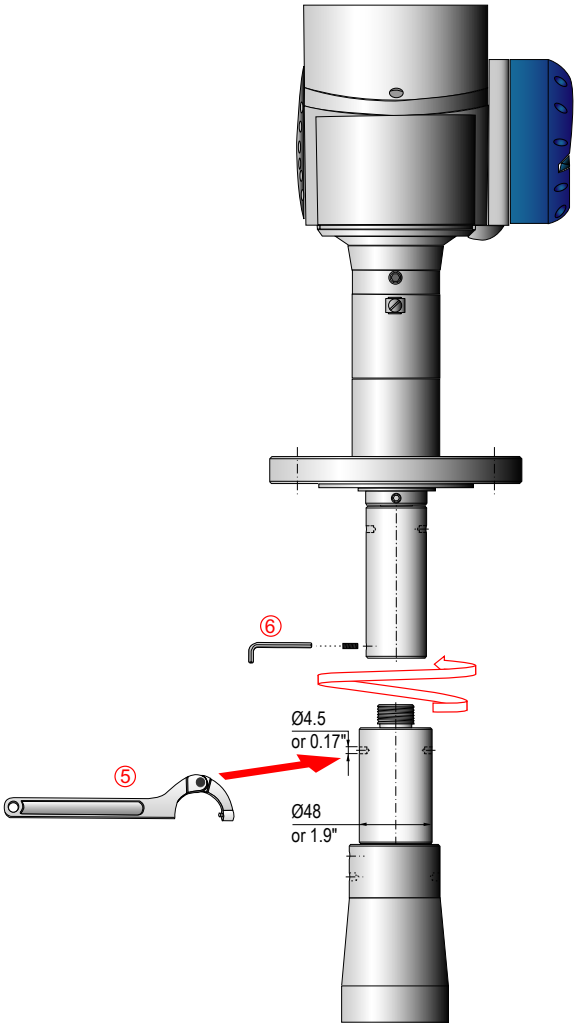
1. Unscrew M6 socket set locking screw with 3 mm or 1/8” allen (hexagonal) key preventing removal of the primary extension unit from the main housing assembly.
2. Unscrew the primary extension unit by using an adjustable pin wrench (see illustration above) and two 4.5 mm or 0.17 “ sockets provided. The wrench must be adapted to the part diameter (Ø40 mm or 1.6”).



3. Screw supplementary exension unit into the main housing assembly using the pin wrench. Repeat as necessary depending on the number of supplementary units required.

4. Lock the unit(s) in place with an M6 socket screw as shown. Tighten with a 3 mm or 1/8” allen (hexagonal) key.





5. Screw the primary extension unit and DN80 horn antenna into the supplementary extension unit(s) using a pin wrench adapted to the part diameter (Ø48 mm or 1.9”) and socket provided in the part (Ø4.5 mm or 0.17”).

6. Lock the parts in place - screw the M6 socket screw in and tighten with a 3 mm or 1/8” allen (hexagonal) key.

7.0 Technical data

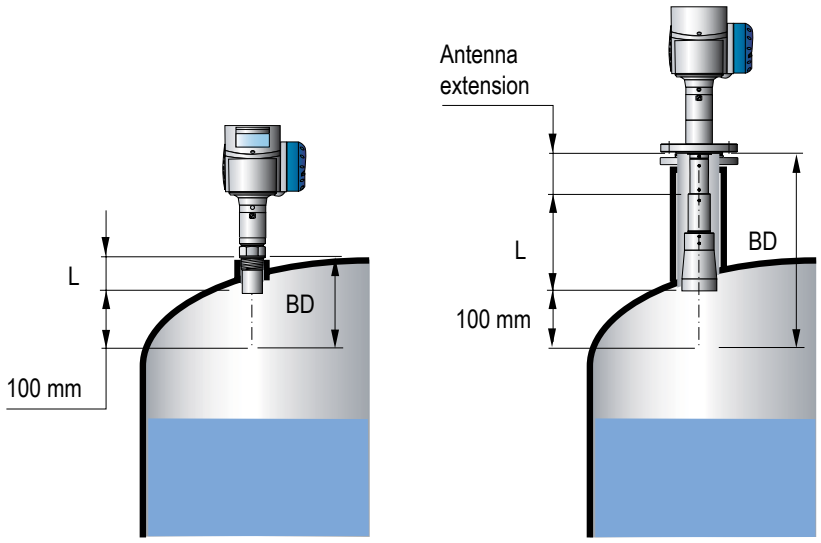
7.1.1 Technical data

Input		
Function:		K-band FMCW radar
Parameter:		Level, distance, volume and reflectivity
Min. tank height:		0.5 m / 1.5 ft
Max. measuring range:		40 m / 131 ft
Blocking distance		Antenna extension + antenna length
(dead zone):		+ 0.1 m/ 4”
Output		
Output signal:	Output 1	4 … 20 mA & HART® signal
		selectable: 3.8 … 20.5 mA acc. to NAMUR NE43 & HART signal
Signal on alarm:	Errors can be displayed in a variety of formats	
	- Error icon on display screen in normal mode	
	- Text warnings on display screen for errors in program mode	
	- Current output (selectable: 3.6, 22 mA or Hold)	
	- Errors, warning & flag trends for digital interfaces	
Max. load:	350 ohms	
Performance characteristics		
Measuring accuracy		
Reference conditions	Temperature	+20°C ± 5°C/ +68°F ± 9°F
acc. to IEC770	Pressure	1013 mbar abs. ± 20 mbar or 14.69 psig ± 0.29 psi
	Rel. Air. humidity	60% ± 15%
Resolution		1 mm/ 0.04 “
Accuracy		± 3 mm/ 0.12”

Operating conditions		
Installation		
Installation instructions:	see sections 1 and 2	
Start-up time	40 seconds	
Beam angle	Horn antenna DN 40	20°
	Horn antenna DN 50	15°
	Horn antenna DN 80	10°
Environment		
Ambient temperature	-40…+80°C/ -40…+175°F;	
	EExi: -40…+60°C/ -40… +140°F*	
Storage temperature	-40…+85°C/ -40…+185°F	
Accuracy:	0.05%/rel.20 mA;20°C/ 70°F	
Resolution:	± 2µA	
Temperature drift:	Typically 50 ppm/K	
Electromagnetic compatibility:	Conforms to Directive 89/336/CEE in conjunction with EN 61326 (1+2) - immunity and emmisions	
Process		
Temperature	Flange temperature:	-40…+200°C/ -40…+300°F (Ex: refer to relevant device's approval and temperature class)
	Thermal shock resistance:	100°C/ min
Pressure	Operating pressure:	-1…40 bar/ -14.5…580 psig;
		subject to process connection used and flange temperature
	Dielectric constant:	> 1.8
Vibration resistance:		IEC 68-2-6 and prEN 50178 (10-57Hz: 0.075 mm / 57-150 Hz: 1 G)
Protection category:		IP 66/67 equiv. to NEMA 6 - 6X
* refer to ATEX Supplementary Instructions supplied on a CD-ROM with the device		

Mechanical data		
Material:	Housing	Aluminium
	Wetted parts	Stainless steel (1.4404/ 316L) or Hastelloy C-22 (2.4602)
	Process fitting	Stainless steel (1.4404/ 316L) or Hastelloy C-22 (2.4602)
	Gaskets	Viton (-40…+200°C/ -40…+300°F); Kalrez 6375 (-20…+200°C/ -5 …+300°F)
Process connections:	Thread	G 1 1/2" or NPT 1 1/2"
	Flanges	DN 40…DN 150 (PN 40/PN 16);1 1/2"…8" (150 lbs/ 300 lbs); 10 K (40…100A)
Electrical connection for 2-wire supply		
Cable entry	M20x1.5; 1/2 NPT; G 1/2	
Terminals	0.5…1.5 mm²	
Terminals output 1-HART®	Non-Ex/ EEx i	24 Vdc (14 … 30 Vdc)**
	EEx d	24 Vdc (20 … 36 Vdc)**
** observe correct polarity of the electrical system		
Human interfaces		
PACTware:	Open source device tool manager for remote display	
	and configuration	
Display screen (optional):	160x160 pixels in 8-step greyscale with 4 keys. Wizard-driven.	
	9 languages available	

7.1.2 Blocking distance



G 1½ Modular DN80

DR7000 radar level meter blocking distance* is defined as:

antenna length+antenna extension (x number of units)+100 mm (4")**

*measured from the flange facing or thread stop
**only for modular DN80 antenna

The table below gives the values of antenna length and blocking distance depending on antenna type

Antenna type	Antenna length, L	Blocking distance, BD
	in mm or inches	in mm or inches
DN 40	38,5 or 1.5"	138,5 or 5.5"
G / NPT 1½"	77 or 3"	177 or 7"
DN 50	50 or 2"	150 or 5.9"
Single-piece DN 80	160 or 6.3"	260 or 10.3"
Modular DN 80	218 or 8.6"***	318 or 12.5"****

*** This is the basic antenna length. You can add up to 10 extension units of length 105 mm or 4.2".

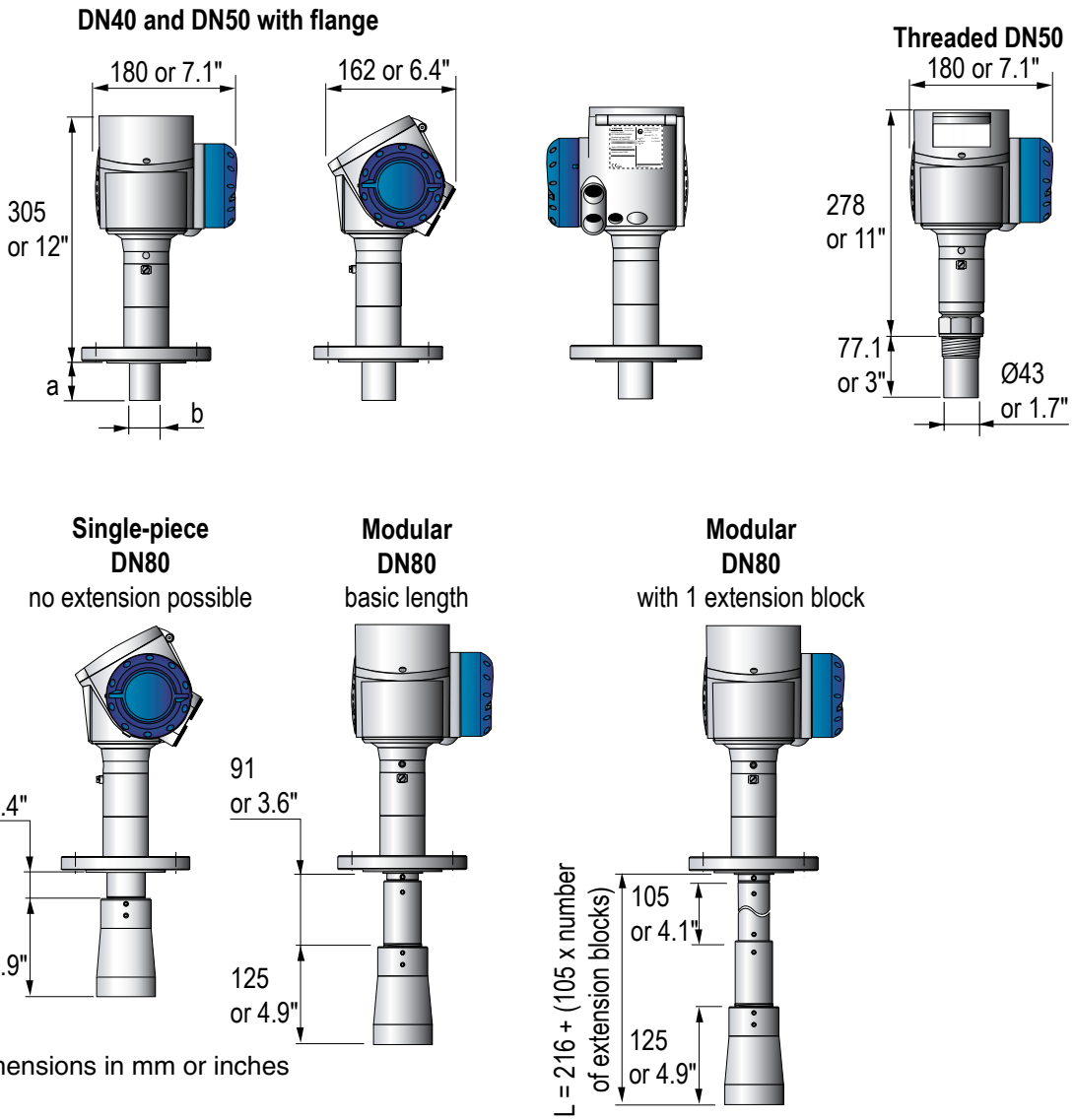
**** This is the basic blocking distance. You can add up to 10 extension units of length 105 mm or 4.2".

7.1.3 Hazardous areas

Please refer to Appendix A for devices approved for use in potentially explosive atmospheres.

7.2 Dimensions and weights

Level meter dimensions



Dimensions in mm or inches

Weights

Housing and connection (stainless steel 316)	Weight [kg]	Weight [lb]
Housing	3.3	7.3
Flange connection DN 25…80 / ANSI 1"…3"	4…7	8.8…15.4
Flange connection DN 100...150 / ANSI 4"…6"	7…12	15.4…26.5
Thread connection	3	6.6

8.0 Measuring principle

8.1 General principle

A radar signal is emitted via an antenna, reflected on the product surface and received after a time t. The RADAR principle used is FMCW (Frequency Modulated Continuous Wave).

Operating principle

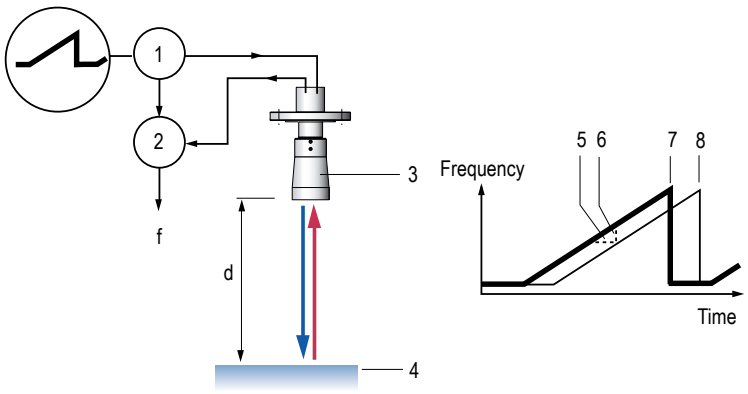
The FMCW-radar transmits a high frequency signal whose frequency increases linearly during the measurement phase (called the frequency sweep). The signal is emitted, reflected on the measuring surface and received with a time delay, t. For further signaL processing the difference df is calculated from the actual transmit frequency and the receive frequency. The difference is directly proportional to the distance i.e. a large frequency difference correspond to a large distance and vice versa. The frequency difference is transformed via a Fourier transformation (FFT) into a frequency spectrum and then the distance is calculated from the spectrum. The level results from the difference between tank height and measuring distance.

Measuring accuracy

The measuring accuracy of a FMCW radar is determined from the linearity of the frequency sweeps and their reproducibility. The linearity correction is deduced via reference measurement of the oscillator. The non-linearity is corrected up to 98%. With the PLL technology (Phase Locked Loop) the signal frequency is directly recorded as a digital data and the converter oscillator locks automatically on the right frequency.

1. radar frequency linearly changed
2. delay time due to wave propagation
3. differential frequency formed

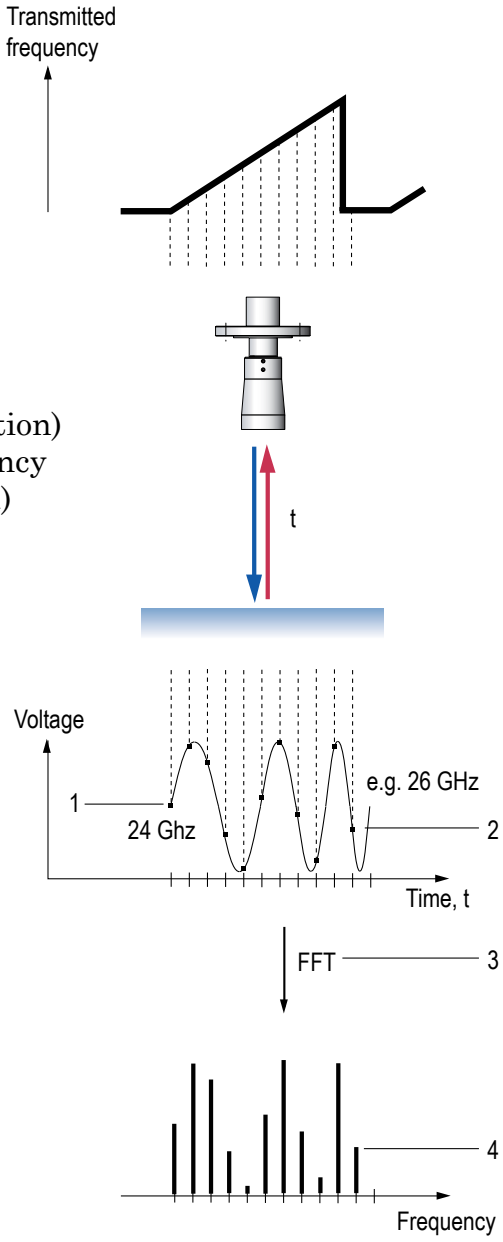
As the transmit frequency is changed during a short time interval by FMCW radar the transmitted frequency has to follow the nominal frequency within micro seconds. This ensues via modern, fast electronic and processors.



1. Transmitter
2. Receiver
3. Antenna
4. Product surface
5. Differential delay time, t
6. differential frequency, df
7. Frequency transmitted
8. Frequency received

d= distance to product surface
f= frequency proportional to distance, d

FMCW radar digital signal processing



1. Sampling points
2. Voltage values
3. Fast Fourier Transform (discrete mathematical transformation)
4. Discrete voltage values over frequency (singular: spectrum, plural: spectra)

8.2 Measuring modes

The DR7000 can find the level using three measuring modes, depending on the dielectric constant of the product.

- Direct mode: for level and/or interface measurement, for products with εr > 1.4 (depending on the probe used).
- Partial tank bottom following mode (TBF): for level measurement of products with fairly low dielectric constants (εr from 2 to 3)
- Full tank bottom following mode (TBF): for level measurement of products with low dielectric constants (εr < 2).

Direct mode

This is described under General Principle.

Tank bottom following

TBF (Tank Bottom Following) mode is used when an insufficient amount of the RADAR signal is reflected from the product surface. It utilizes the apparent shift of the tank bottom signal (h becomes hv - see diagram) resulting from different microwave propagation rates in the air and in the tank product.
This mode uses the principle that while not much of the pulse is reflected, the speed of the signal changes. This is because the speed of light in a product like oil is lower than the speed of light in a gas such as air.
The time it takes for the signal to reflect back from the tank bottom when the tank is empty is known from the initial autocalibration. The level may be calculated from the difference between the pulse reflection time from the tank bottom of the full or partially filled tank versus the reflection time off the empty tank bottom. The difference in time is proportional to product level.
The tank bottom must be able to reflect back a strong signal. For this reason TBF is best used in flat-bottomed tanks - tanks with conical bottoms are unsuitable installations.
The dielectric constant of the tank product must be known as exactly as possible. (This parameter can be determined by a DREXELBROOK service technician from the recording of a tank filling or draining operation with the user program. The level in the tank should in this case change over the largest possible range.).
When measurements are taken with activated TBF mode, an estimated range for the measured value is determined on the basis of the shifted tank bottom signal, and inaccuracy of the dielectric constant of ± 10% is taken into consideration. If no evaluable measuring signal is obtained within this range, a substitute measured value is calculated direct from the tank bottom signal. This feature of the TBF mode even allows measurement in tanks without a direct useful signal, provided the tank bottom remains visible to the RADAR device through the product.

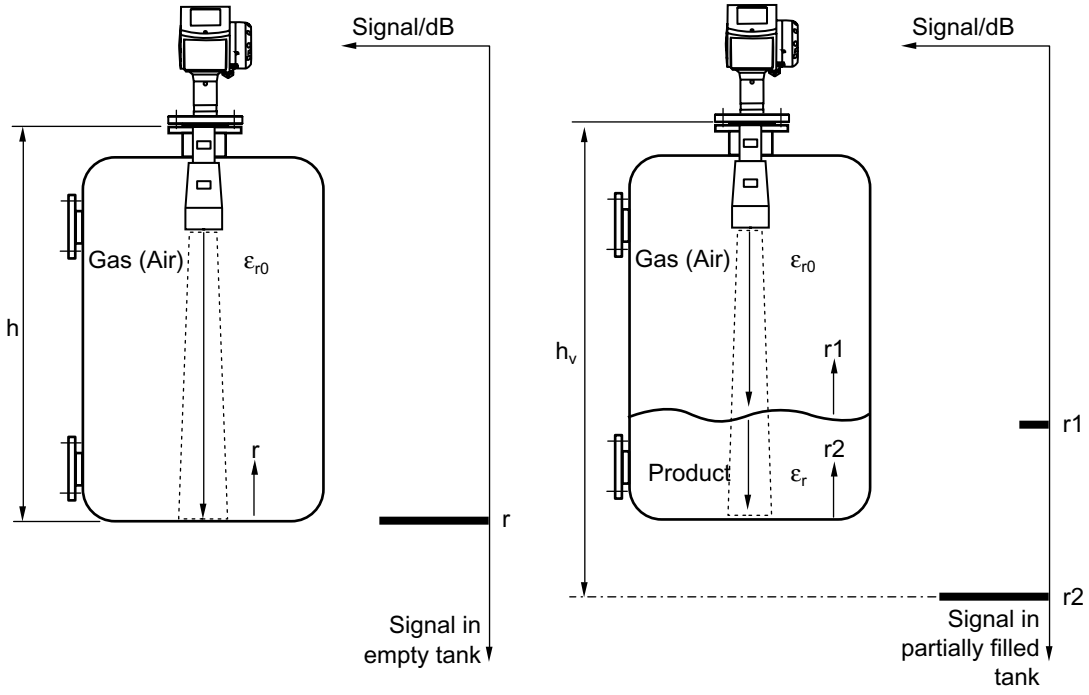
Since the exact position of the tank bottom must be known for this process, it is advisable when using the TBF to determine the tank height automatically with

a completely empty tank, using the empty tank spectrum quick setup mode. Note that when measuring with the substitute measured value determined from the tank bottom signal, the measuring accuracy will decrease by the factor √εr - 1). For an εr of 2.25, accuracy decreases by one-half, i.e. the possible deviation will double; if εr is only 1.56,accuracy decreases to one-quarter.
When the (Partial) TBF mode is used, the maximum measuring range is approx. 10% smaller, i.e. max. tank height = 18 m.
The measuring mode is selected in the advanced setup menu C.1.13.0

- **Partial:** when this option has been selected, the TBF mode is activated only in the vicinity of the tank bottom, i.e. at low levels (max. 20% of the tank height but a minimum of 0.6 m). At higher levels, the normal measuring method is used (reflection from the product surface). This method is sufficient for most applications with poorly reflecting products. However, as mentioned before, Product εr (function C1.14.0) must be as exact as possible.

- **Full:** When this option is selected, the TBF mode is active over the total measuring range (tank height). For tank heights above 16 m, however, measuring accuracy is additionally affected. Product εr (function C1.14.0) must be as exact as possible.

TBF mode



Approvals

Approvals for the CE-marking are standard. When ordered with the appropriate options, the device can be approved for use in hazardous areas.

Approval	Type	Description
CE-mark	n/a	Conforms to applicable EU directives. Device standard.
ATEX	Ex ia	ATEX II 1 G D or II 1/2 G D or II 2 G D;
KEMA 04ATEXxxxxX		EEx ia IIC T6…T3 T65°C … T90°C IP 6X
	Exd	ATEX II 1/2 G D or II 2 G D;
		EEx d [ia] IIC T6...T3 T65°C … T90°C IP 6X
FM	Ex ia	Intrinsically Safe (IS)
CSA		IS CL I, DIV 1, GR A,B,C,D
		DIP CL II, III, DIV 1, GR E,F,G
		NI ANI CL I, DIV 2, GR A,B,C,D (FM Only)
		DIP CL II, III, DIV 1 GR E,F,G
		Sensor Probe suitable for use in DIV 1 or ZONE 0
		DIV 1 or ZONE 0
		CL I, Zone 0, AEx ia IIC
		CL I, Zone 2, GR IIC
		T6, Ta = 60° C
	Ex d	Explosion Proof (XP)
		XP CL I, DIV 1, GR A,B,C,D (FM Only) CL I, DIV 2, GR A,B,C,D
		DIP CL II, III, DIV 1, GR E,F,G
		NI ANI CL I, DIV 2, GR A,B,C,D (FM Only)
		DIP CL II, III, DIV 2 GR F,G
		Sensor Probe suitable for use in DIV 1 or ZONE 0
		CL I, Zone 0, AEx d ia IIC
		CL I, Zone 2, GR IIC
		T6, Ta = 60° C
European Union (EU)	Radio	The device meets requirements of Radio Equipment and Telecommunications Terminal Equipment Directive 1999/5/EC (R&TTED) when installed in closed metallic tanks or silos. According to article 6.4 of the R&TTED, product is marked with the CE sign, notified body number (0682) and Class II identifier (alert sign). According to EN300440, the radiated power is < -30 dBm EIRP.
United States of America (USA)	Radio	The device complies with USA FCC Part 15 Rules (FCC ID JH5-OPTIWAVE7000C) when installed in totally enclosed metal tanks.

Glossary of terms

Dielectric constant
Also known as εr, DK and relative permattivity. An electrical property that affects the amount of energy from a RADAR signal reflected off the product surface. Products have different values: water has an er = 80 and oil has an εr = 2.4.

Distance piece
Optional component separating the housing from the process connection and antenna assembly used in high temperature applications.

Frequency sweep
The transmission frequency of the FMCW radar signal rises linearly over time.

FMCW
Frequency modulated continuous wave RADAR method. The signal is continuously present but the frequency is modulated, usually in successive linear ramps over time (frequency sweep).

Horn (cone) antenna
Common antenna used for process level applications. Use for the controlled emission RADAR waves and collection of echoes.

Interference signals
False RADAR echoes that are received due to tank internals : agitators, support beams, weld lines, abrupt changes in tank diameter, etc.

RADAR echo
Reflected signal/wave back from the product surface.

Waveguide
PTFE component used to guide the emitted RADAR waves correctly into the horn antenna.

9.0 Factory Assistance

Telephone Assistance

If you have questions about your AMETEK Drexelbrook equipment:

- Contact your local Drexelbrook representative
- Call the Drexelbrook Service department toll-free at:
  1-800-527-6297 (US and Canada) or
  215-674-1234 (Outside North America)
- Fax the following information to the Service department at: 215-443-5117.

To expedite assistance, please provide the following information:

Instrument Model Number: _____

Original Purchase order number: _____

Material being measured: _____

Temperature: _____

Pressure: _____

Agitation: _____

Brief description of the problem: _____
_____
_____

Checkout procedures that have failed: _____
_____
_____
_____

Equipment Return / Warranty

In order to provide the best service, any equipment being returned for repair or credit must be pre-approved and have a return number issued by the factory.

In many applications, the equipment is exposed to hazardous materials.

- OSHA mandates that our employees be informed and protected from hazardous materials.
- Material Safety Data Sheets (MSDS) listing the hazardous material that the system has been exposed to must accompany any return.
- It is your responsibility to fully disclose all chemicals and decontaminate the returned items.

Equipment Return (Continued)

To obtain a return authorization number (RA#), contact the Service department at:
1-800-527-6297 (US and Canada) or
215-674-1234 (Outside North America).

Please provide the following information:

Model Number of Returned Equipment:_____

Serial Number: _____

Original Purchase Order Number:_____

Process Material that the equipment has been exposed: _____

MSDS for any hazardous materials

Billing Address:_____

Shipping Address:_____

Purchase Order Number for Repairs: _____

Please include a purchase order number even if the repair is under warranty. If repair is covered under warranty, you will not be charged.

Ship equipment freight prepaid to:
AMETEK Drexelbrook
205 Keith Valley Road
Horsham, PA 19044

COD shipments will not be accepted.

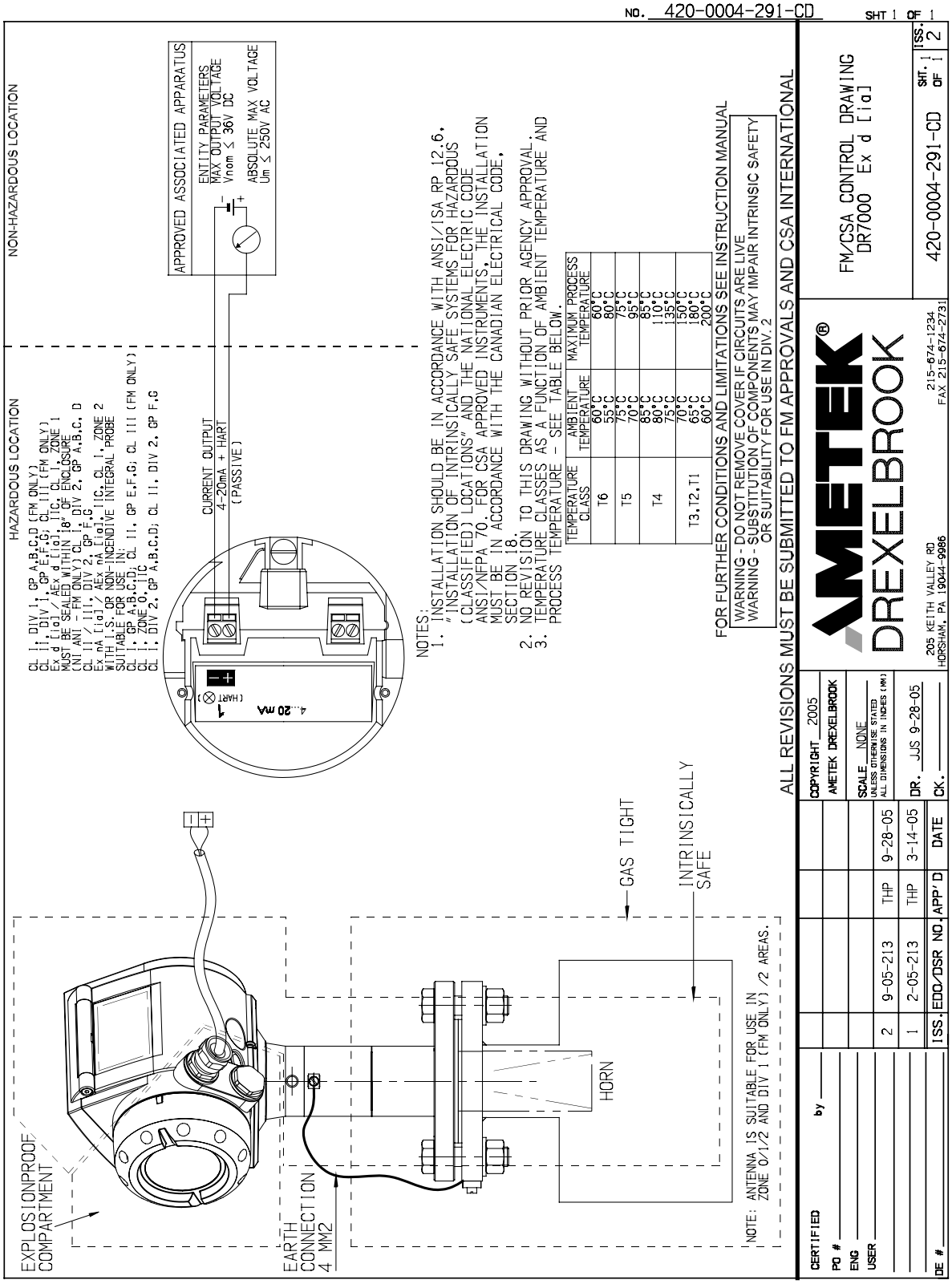
AMETEK Drexelbrook warrants its products free of material defects or manufacturing defects for a period of 1 year after date of shipment.

Field Service

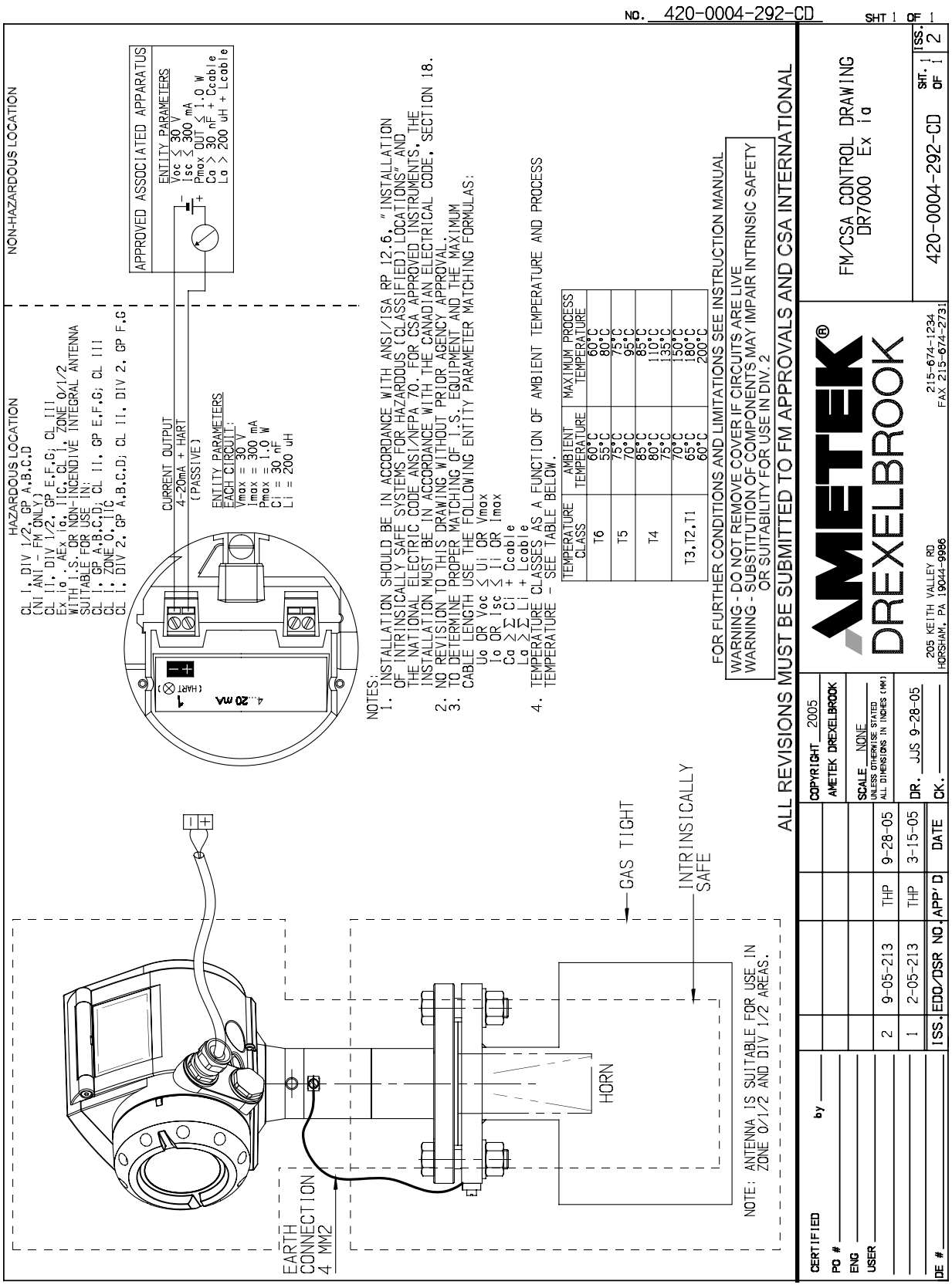
Trained field service personnel are available on a time-plus-expense basis to assist in start-ups, diagnosing difficult application or equipment problems, or in-plant training of personnel. Preventive Maintenance and Calibration Certification service contracts are also available to maintain plant efficiency. Contact the Service department for further information.

10.0 Control Drawings

FM / CSA Control Drawings


NO. 420-0004-291-CD
SHT 1 OF 1
NON-HAZARDOUS LOCATION
HAZARDOUS LOCATION
CL I, DIV 1, GP A,B,C,D (FM ONLY)
CL I, DIV 1, GP E,F,G; CL II, III (FM ONLY)
Ex d IIC/ AEx d IIC; CL I, ZONE 1
MUST BE SEALED WITHIN 18" OF ENCLOSURE
CNI AND FM ONLY: CL I, DIV 2, GP A,B,C, D
CL I, DIV 2, GP E, F, G
CL nA IIC/ AEx nA IIC; CL I, ZONE 2
WITH I.S. OR NON-INCENDIVE INTEGRAL PROBE
SUITABLE FOR USE IN:
CL I; ZONE 0, IIC
CL I; DIV 2, GP A,B,C,D
CL II, GP E,F,G; CL III (FM ONLY)
CL I, DIV 1, GP A,B,C,D; CL II, DIV 2, GP F,G
APPROVED ASSOCIATED APPARATUS
ENTITY PARAMETERS
MAX OUTPUT VOLTAGE
Vnom ≤ 36V DC
ABSOLUTE MAX VOLTAGE
Um ≤ 250V AC
CURRENT OUTPUT
4-20mA + HART
(PASSIVE)
4...20 mA
(HART)
NOTES:
1. INSTALLATION SHOULD BE IN ACCORDANCE WITH ANSI/ISA RP 12.6, "INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS" AND THE NATIONAL ELECTRIC CODE ANSI/NFPA 70. FOR CSA APPROVED INSTRUMENTS, THE INSTALLATION MUST BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, SECTION 18.
2. NO REVISION TO THIS DRAWING WITHOUT PRIOR AGENCY APPROVAL.
3. TEMPERATURE CLASSES AS A FUNCTION OF AMBIENT TEMPERATURE AND PROCESS TEMPERATURE - SEE TABLE BELOW.
TEMPERATURE CLASS | AMBIENT TEMPERATURE | MAXIMUM PROCESS TEMPERATURE
T6 | 60°C | 60°C
 | 55°C | 80°C
T5 | 75°C | 75°C
 | 70°C | 95°C
T4 | 85°C | 85°C
 | 80°C | 110°C
 | 75°C | 135°C
T3,T2,T1 | 70°C | 150°C
 | 65°C | 180°C
 | 60°C | 200°C
FOR FURTHER CONDITIONS AND LIMITATIONS SEE INSTRUCTION MANUAL
WARNING - DO NOT REMOVE COVER IF CIRCUITS ARE LIVE
WARNING - SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY OR SUITABILITY FOR USE IN DIV. 2
ALL REVISIONS MUST BE SUBMITTED TO FM APPROVALS AND CSA INTERNATIONAL
AMETEK®
DREXELBROOK
205 KEITH VALLEY RD.
HORSHAM, PA. 19044-9986
215-674-1234
FAX 215-674-2731
FM/CSA CONTROL DRAWING
DR7000 Ex d [ia]
420-0004-291-CD
SHT. 1 OF 1
ISS. 2
COPYRIGHT 2005
AMETEK DREXELBROOK
SCALE NONE
UNLESS OTHERWISE STATED
ALL DIMENSIONS IN INCHES (MM)
DR. JJS 9-28-05
CK. ____
DATE
APP'D
EDO/DSR NO.
ISS.
2 9-05-213 THP 9-28-05
1 2-05-213 THP 3-14-05
CERTIFIED by ____
PO # ____
ENG ____
USER ____
DE # ____
EXPLOSIONPROOF COMPARTMENT
EARTH CONNECTION 4 MM2
GAS TIGHT
INTRINSICALLY SAFE
HORN
NOTE: ANTENNA IS SUITABLE FOR USE IN ZONE 0/1/2 AND DIV 1 (FM ONLY) /2 AREAS.

FM / CSA Control Drawings


NO. 420-0004-292-CD
SHT 1 OF 1
NON-HAZARDOUS LOCATION
HAZARDOUS LOCATION
CL I, DIV 1/2, GP A,B,C,D
(NI ANI - FM ONLY)
CL II, DIV 1/2, GP E,F,G; CL III
Ex ia , AEx ia, IIC, CL I, ZONE 0/1/2
WITH I.S. OR NON-INCENDIVE INTEGRAL ANTENNA
SUITABLE FOR USE IN:
CL I, GP A,B,C,D; CL II, GP E,F,G; CL III
CL I, ZONE 0, IIC
CL I, DIV 2, GP A,B,C,D; CL II, DIV 2, GP F,G
APPROVED ASSOCIATED APPARATUS
ENTITY PARAMETERS
Voc ≤ 30 V
Isc ≤ 300 mA
Pmax OUT ≤ 1.0 W
Ca ≥ 30 nF + Ccable
La ≥ 200 uH + Lcable
CURRENT OUTPUT
4-20mA + HART
(PASSIVE)
ENTITY PARAMETERS
EACH CIRCUIT:
Vmax = 30 V
Imax = 300 mA
Pmax = 1.0 W
Ci = 30 nF
Li = 200 uH
4...20 mA
HART
NOTES:
1. INSTALLATION SHOULD BE IN ACCORDANCE WITH ANSI/ISA RP 12.6, "INSTALLATION OF INTRINSICALLY SAFE SYSTEMS FOR HAZARDOUS (CLASSIFIED) LOCATIONS" AND THE NATIONAL ELECTRIC CODE ANSI/NFPA 70. FOR CSA APPROVED INSTRUMENTS, THE INSTALLATION MUST BE IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, SECTION 18.
2. NO REVISION TO THIS DRAWING WITHOUT PRIOR AGENCY APPROVAL.
3. TO DETERMINE PROPER MATCHING OF I.S. EQUIPMENT AND THE MAXIMUM CABLE LENGTH USE THE FOLLOWING ENTITY PARAMETER MATCHING FORMULAS:
Uo OR Voc ≤ Ui OR Vmax
Io OR Isc ≤ Ii OR Imax
Ca ≥ ΣCi + Ccable
La ≥ ΣLi + Lcable
4. TEMPERATURE CLASSES AS A FUNCTION OF AMBIENT TEMPERATURE AND PROCESS TEMPERATURE - SEE TABLE BELOW.
TEMPERATURE CLASS | AMBIENT TEMPERATURE | MAXIMUM PROCESS TEMPERATURE
T6 | 60°C | 60°C
55°C | 80°C
T5 | 75°C | 75°C
70°C | 95°C
T4 | 85°C | 85°C
80°C | 110°C
75°C | 135°C
T3,T2,T1 | 70°C | 150°C
65°C | 180°C
60°C | 200°C
FOR FURTHER CONDITIONS AND LIMITATIONS SEE INSTRUCTION MANUAL
WARNING - DO NOT REMOVE COVER IF CIRCUITS ARE LIVE
WARNING - SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY OR SUITABILITY FOR USE IN DIV. 2
ALL REVISIONS MUST BE SUBMITTED TO FM APPROVALS AND CSA INTERNATIONAL
AMETEK®
DREXELBROOK
205 KEITH VALLEY RD
HORSHAM, PA 19044-9986
215-674-1234
FAX 215-674-2731
FM/CSA CONTROL DRAWING
DR7000 Ex ia
420-0004-292-CD
SHT. 1 OF 1
ISS. 2
COPYRIGHT 2005
AMETEK DREXELBROOK
SCALE NONE
UNLESS OTHERWISE STATED ALL DIMENSIONS IN INCHES (MM)
DR. JJS 9-28-05
CK.
CERTIFIED by
PO #
ENG
USER
DE #
ISS. | EDO/DSR NO. | APP'D | DATE
2 | 9-05-213 | THP | 9-28-05
1 | 2-05-213 | THP | 3-15-05
EARTH CONNECTION 4 MM2
GAS TIGHT
INTRINSICALLY SAFE
HORN
NOTE: ANTENNA IS SUITABLE FOR USE IN ZONE 0/1/2 AND DIV 1/2 AREAS.

Appendix A: Supplementary Installation & Operating Instructions

General safety information

This document only contains explosion protection information for ATEX applications. For all other data, use the Quick Start and Online Handbook for DR7000 radar level meters.

Warning

Install, commission and service the device only if you are trained for explosion protection of installations.

Device description

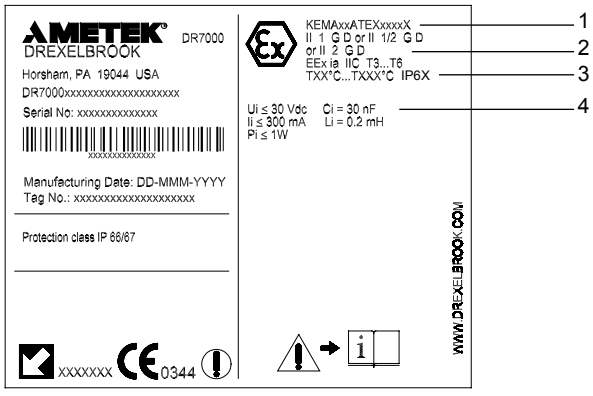
The DR7000 is a 2-wire level meter using FMCW (Frequency-Modulated Continuous Wave) radar technology. It is used for measuring level, volume, distance to surface, and reflectivity of liquids, pastes, slurries and solid particles, granulates and powders. It is suitable for installation on storage tanks, process tanks and stilling wells. Measurements are displayed via a DTM (device type manager) for remote communication or on an optional integrated display screen with wizard-driven setup and online help functions.

The DR7000 is approved for use in potentially explosive atmospheres when equipped with the appropriate options.

ATEX nameplates

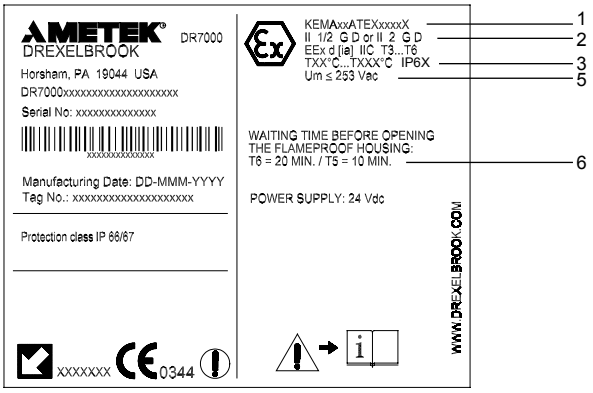
Information for ATEX applications is indicated below

EEx ia nameplate



1. ATEX certification agency code. Refer to section 1.2 for all temperature information.
2. Equipment approval categories
3. Types of device protection including approved Gas Groups (IIA, IIB. or IIC) and temperature classes for hazardous areas and maximum surface temperature
4. Intrinsically-safe circuit data

EEx d nameplate



5. Maximum voltage in accordance with EN 50014 / IEC 60079-0
6. Minimum waiting time after power-off before it is safe to open the terminal compartment

Standards and approvals

In compliance with European Directive 94/9/EC (ATEX 100a), the ATEX version of the level meter described in these Supplementary Instructions conforms to European Standards EN 50014 +A1 +A2, EN 50018 +A1, EN 50020, EN 50281-1-1 +A1, and EN 50284. It is certified for use in hazardous areas by the KEMA certification agency under KEMA 07ATEX0068 X.

Warning

Read the ATEX approval certificate for the DR7000 carefully and observe boundary conditions given.

The DR7000 radar level meter is suitable for use in potentially explosive atmospheres of all flammable substances in Gas Groups IIA, IIB and IIC and for applications requiring Category 1G (gases, vapours or mists), 1D (dust), 1/2G, 1/2D, 2G or 2D equipment when fitted with the appropriate options.

Approved category defintions

Category 1
The meter is installed in hazardous areas requiring Category 1G or 1D equipment.

Category 1/2
The signal converter is installed in hazardous areas requiring Category 2G or 2D equipment. The antenna is installed in hazardous areas requiring Category 1G or 1D equipment.

Category 2
The meter is installed in hazardous areas requiring Category 2G or 2D equipment.

1 Mechanical Installation

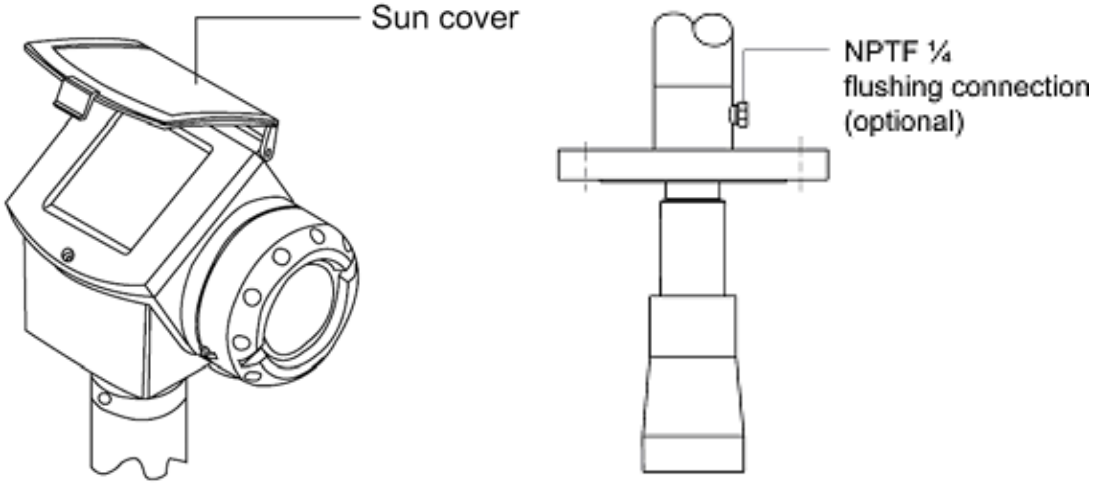
1.1 Precautions

When you install the device, observe
- the special conditions for safe use*
- the Essential Health and Safety Requirements*

* Read the EC-Type Examination Certificate in the last section of this manual.

1.1.2 Electrostatic Discharge

Warning: Danger of electrostatic discharge from sun cover.
There is a risk of electrostatic discharge from the plastic sun cover.
Take the necessary antistatic precautions when
- handling
- installing, or
- using the device in potentially explosive atmospheres. Check that all personnel and equipment are properly grounded. If the sun cover needs cleaning, wipe with a damp cloth.



1.1.3 Optional flushing system

If delivered with the device, the flushing connection is closed off by a 1/4“ screw. The NPTF plug is engaged on a minimum of five threads.
Connection and operation of the flushing connection fall within the responsibility of the operator. When this screw is removed, the operator is responsible for ensuring conformance with the ’Ex’ requirements pertaining to the flushing system (e.g. fitting a flame trap).
The operator is also responsible for selection of a suitable flushing medium.

1.2 Operating conditions

The allowable ambient temperature and corresponding process temperature range for the DR7000 level meters depends on the ATEX equipment category and temperature classes marked on the nameplate.

1.2 Operating conditions (Continued)

Ambient and process temperatures		
Equipment category II 1 G (EEx i devices only)		
Temperature class	**Ambient temperature**	**Flange temperature**
T6	-20°C … +60°C	-20°C … +60°C
Equipment category II 1/2 G		
Temperature class	**Ambient temperature**	**Flange temperature**
T6	-40°C … +60°C	-20°C … +60°C
T5	-40°C … +75°C	-20°C … +60°C
T4	-40°C … +85°C	-20°C … +60°C
Equipment category II 2 G		
Temperature class	**Ambient temperature**	**Flange temperature**
T6	-40°C … +60°C	-40°C … +60°C
	-40°C … +55°C	-40°C … +80°C
T5	-40°C … +75°C	-40°C … +75°C
	-40°C … +70°C	-40°C … +95°C
T4	-40°C … +85°C	-40°C … +85°C
	-40°C … +80°C	-40°C … +110°C
	-40°C … +75°C	-40°C … +135°C
T3	-40°C … +70°C	-40°C … +150°C
	-40°C … +65°C	-40°C … +180°C
	-40°C … +60°C	-40°C … +200°C
Equipment categories II 1 D (EEx i devices only), II 1/2 D and II 2 D		
	Ambient temperature	**Flange temperature**
	-40°C … +60°C	-40°C … +200°C
Maximum surface temperature of electronics housing		
Equipment categories II 1 D, II 1/2 D and II 2 D		
Max. ambient temperature	**Max. process temperature**	**Max. surface temperature**
55°C	80°C	65°C
70°C	95°C	80°C
75°C	135°C	86°C
60°C	200°C	90°C
Pressure		
Equipment category	**Allowable process pressure range**	
1G, 1D, 1/2G or 1/2D	Atmospheric pressure (80kPa…110kPa)	
Others	As per non-EEx instrument	

2 Electrical connection

2.1 General notes

Read the information below carefully
Disconnect power supply before wiring

- Do not use the earth terminal in the wiring compartment: use the equipotential bonding system. See section 2.5.
- For ambient temperature >70°C, use heat-resistant cables and cable glands certified for continuous operation above 85°C

2.2 The terminal compartment cover

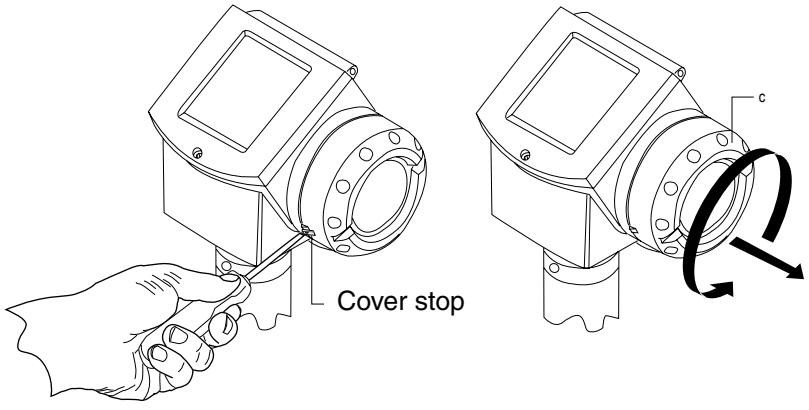
2.2.1 Opening the cover

Procedure

1. Switch off power supply
   EEx d applications: Wait for the time given in the table below before opening

Temperature class	Time to wait after de-energizing the device
T6	20 minutes
T5	10 minutes
T4 and T3	Not necessary

2. Unscrew cover stop
3. Unscrew terminal compartment cover



2.2.2 Closing the cover

Warning: Ex d [ia] applications
Check that the terminal compartment cover is screwed tight and the cover stop is fastened tightly to the cover.

2.3 EEx i equipment

2.3.1 Wiring

1. Wire as for a standard device. Cable entries are supplied on customer demand; those supplied by the customer must have a degree of ingress protection IP ≥ 68 according to EN 60529. Supply the EEx i equipment connected to the device. Use certified intrinsically-safe equipment only.
2. Maximum intrinsically safe values:

Ui ≤ 30 V Ci = 30 nF
Ii ≤ 300 mA Li = 0.2 mH
Pi ≤ 1 W

2.3.2 Supply voltage

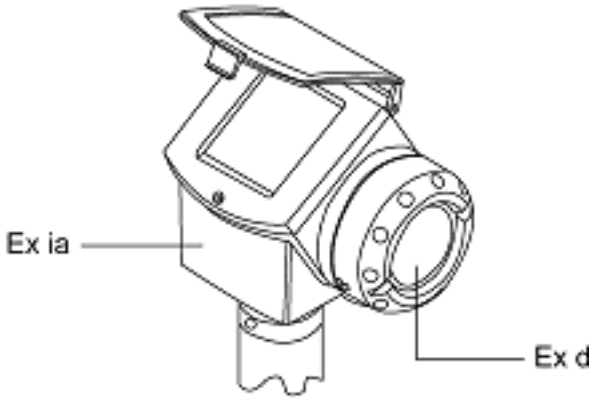
Terminal	Minimum voltage at terminal for an output of 22 mA	Maximum voltage at terminal for an output of 22 mA
1	14 VDC	30 VDC
2*	10 VDC	30 VDC

*additional power supply needed – this does not power the whole device

2.4 EEx d [ia] equipment

2.4.1 General notes

EEx d [ia]-approved equipment have two separate compartments: the electronics block compartment is EEx ia-rated and the terminals compartment is Ex d-rated.



2.4.2 Wiring

1. Use only flameproof and EEx d-approved cable entries and plugs: these are supplied on customer demand. Cable entries and plugs supplied by the customer must have a degree of ingress protection IP ≥ 6x according to EN 60529.
2. If you only use one cable entry, seal the other one with an EEx d-approved plug.
3. All EEx d-approved installations must conform to European standards EN 50018 and EN IEC 60079-1.

Special note: conduit entries

1. Connect the device to an EEx d-approved conduit system.
2. Install a suitable EEx d-approved sealing device: for further information, please refer to European Standard EN 50018.
3. If you only use one cable entry, seal the other one with an EEx d-approved plug.

2.4.3 Supply voltage

Terminal	Minimum voltage at terminal for an output of 22 mA	Maximum voltage at terminal for an output of 22 mA
1	20 VDC	36 VDC
2*	10 VDC	30 VDC

*additional power supply needed – this does not power the whole device

Special notes: load resistor

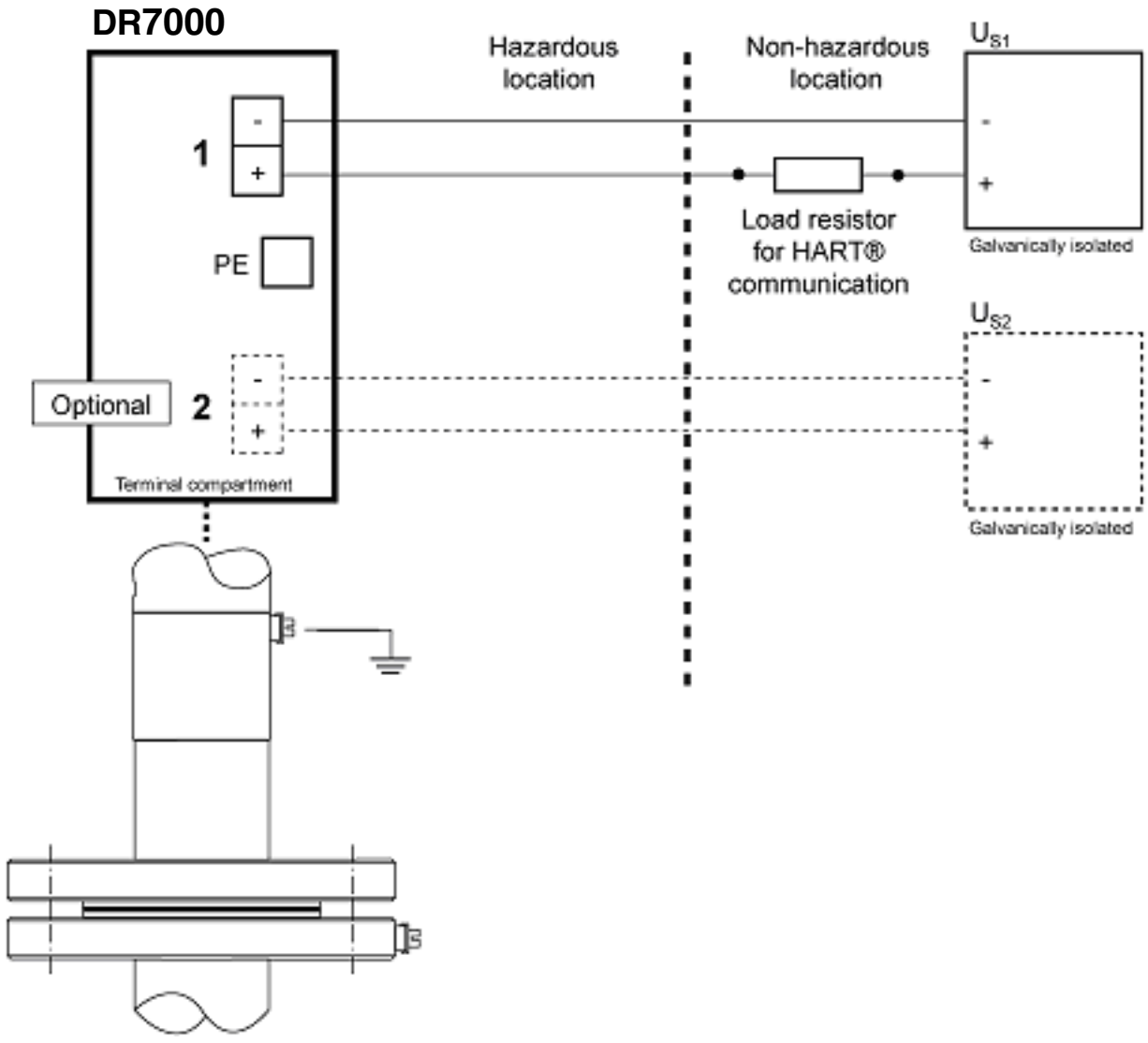
Connect the load resistor to the positive terminal of the power supply and ground the negative connection.

If the load resistor has to be connected to the the negative terminal, do not exceed a loop resistance of 250 ohms.

2.4.2 Power supply

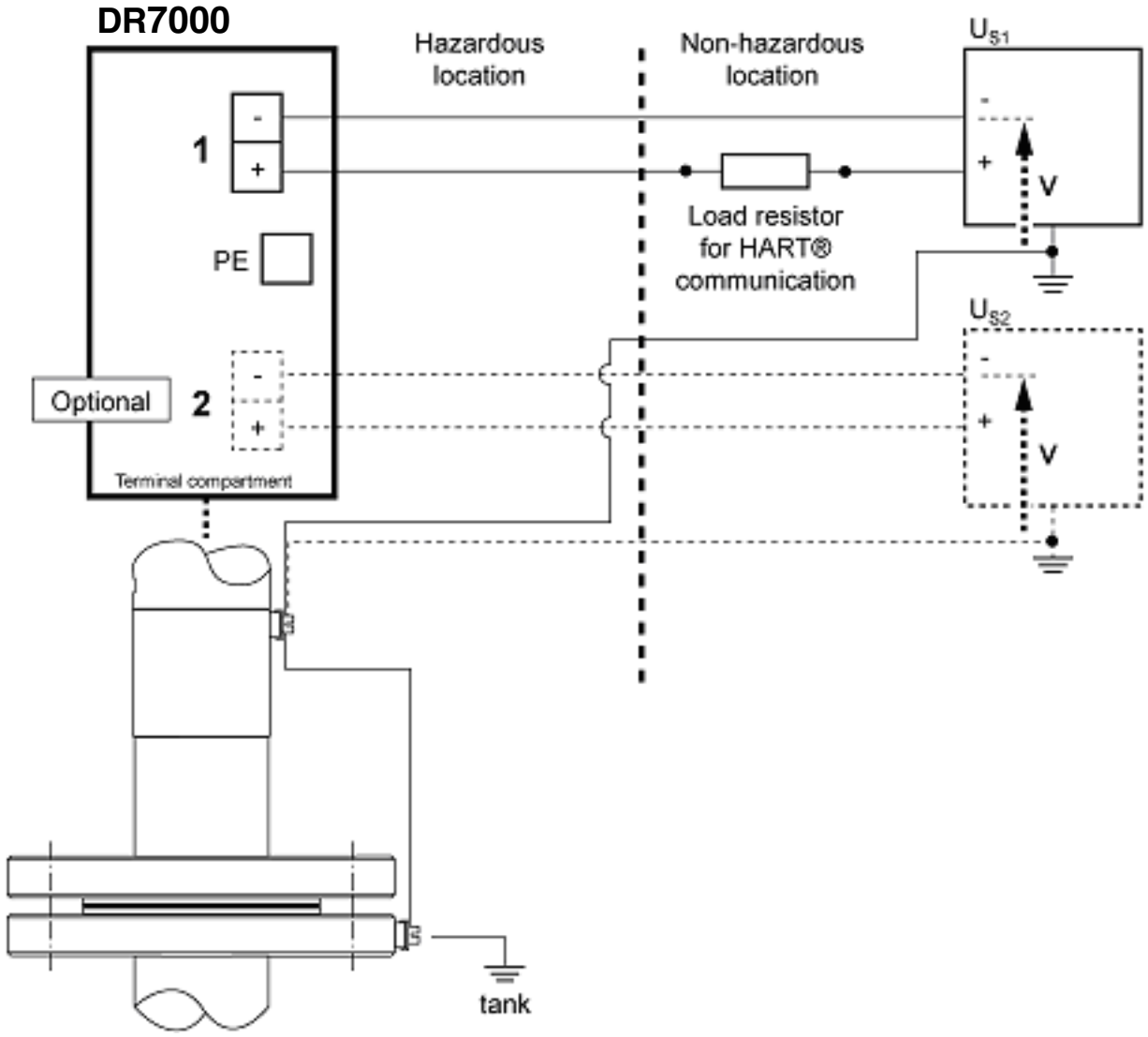
Make sure that the load resistor is connected to the +ve side. If the power supply is not galvanically isolated as in (1.), connect the ground of the power supply to the equipotential system (2.).

1. With galvanic isolation



2.4.2 Power (Continued)

2. Without galvanic isolation



3 Commissioning

Start-up checklist

Do not connect power until you have gone through the checklist below

1. Are the wetted components (antenna, gasket, flange and PTFE cone) resistant to the corrosive properties of the tank product?
2. Does the information given on the nameplate correspond with the application?
3. Have you connected the equipotential bonding system correctly?
4. EEx d applications: Are the cable entries, plugs and adaptors EEx d-approved?
5. EEx i applications: Are you using an intrinsic barrier within the correct parameters? Refer to section 2.3 for the maximum intrinsically safe values for the electrical circuit.
6. Did you install cable entries of the correct internal diameter so that there is a good seal around the cable?

4 Service and maintenance

Maintenance in hazardous areas can ony be carried out by

- the manufacturer
- a Drexelbrook-authorized representative
- technicians under the supervision of authorized inspectors

5 Examination Certificate

EC-Type Examination Certificate KEMA 07ATEX0068 X

420-0004-356 Issue # 1

(1) **EC-TYPE EXAMINATION CERTIFICATE**

(2) Equipment and protective systems intended for use in potentially explosive atmospheres - Directive 94/9/EC

(3) EC-Type Examination Certificate Number: **KEMA 07ATEX0068 X** Issue Number: **1**

(4) Equipment: **Radar Level Instrument Type DR7000 .....**

(5) Manufacturer: **AMETEK Drexelbrook**

(6) Address: **205 Keith Valley Rd., Horsham, PA 19044, USA**

(7) This equipment and any acceptable variation thereto is specified in the schedule to this certificate and the documents therein referred to.

(8) KEMA Quality B.V., notified body number 0344 in accordance with Article 9 of the Council Directive 94/9/EC of 23 March 1994, certifies that this equipment has been found to comply with the Essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres given in Annex II to the directive.

The examination and test results are recorded in confidential test report number 2104892/2.

(9) Compliance with the Essential Health and Safety Requirements has been assured by compliance with:

EN 50014 : 1997 + A1, A2 **EN 50018 : 2000 + A1** **EN 50020 : 2002**
EN 50281-1-1 : 1998 + A1 **EN 50284 : 1999**

(10) If the sign "X" is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

(11) This EC-Type Examination Certificate relates only to the design, examination and tests of the specified equipment according to the Directive 94/9/EC. Further requirements of the directive apply to the manufacturing process and supply of this equipment. These are not covered by this certificate.

(12) The marking of the equipment shall include the following:

II 1 G D or II 1/2 G D or II 2 G D
EEx ia IIC or EEx ia IIB or EEx ia IIA T6 ... T3 T 65 °C ... T 90 °C IP 6X
or
II 1/2 G D or II 2 G D
EEx d[ia] IIC or EEx d[ia] IIB or EEx d[ia] IIA T6 ... T3
T 65 °C ... T 90 °C IP 6X

This certificate is issued on 27 April 2007 and, as far as applicable, shall be revised before the date of cessation of presumption of conformity of (one of) the standards mentioned above as communicated in the Official Journal of the European Union.

KEMA Quality B.V.

O.G. van Es
Certification Manager

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T +31 26 3 56 20 00 F +31 26 3 52 58 00 customer@kema.com www.kema.com Registered Arnhem 09085396

Experience you can trust.

5 Examination Certificate - (Continued)

(13) **SCHEDULE**

(14) **to EC-Type Examination Certificate KEMA 07ATEX0068 X** Issue No. 1

(15) **Description**

The Radar Level Instrument Type DR7000 ..... is used for continuous level measurement of flammable or non-flammable liquids or solid particles, granulates or powders within storage or process tanks or in a stilling well.
The distance between the antenna and the surface of the process medium is measured using a frequency modulated continuous wave radar.
The 2-wire instrument is loop powered. The output signal is a 4 - 20 mA current signal with digital communication (HART protocol).

Either the Radar Level Instrument is completely in type of protection intrinsic safety "i" or the instrument is provided with the power supply compartment in type of protection flameproof enclosure "d". In the latter version a zener barrier circuit board is integrated in the power supply module.

Optionally, the instrument may be provided with a second 4 - 20 mA current output and with display and adjustment capabilities (HMI option).

The ambient temperature range and the flange temperature range, depending on the equipment category required in the area where the instrument is installed, are as listed in the following table:

Equipment category	Ambient temperature range	Flange temperature range
II 1 G	-20 °C ... +60 °C	-20 °C ... +60 °C
II 1/2 G	-40 °C ... +85 °C	-20 °C ... +60 °C
II 2 G	-40 °C ... +85 °C	-40 °C ... +200 °C
II 1 D, II 1/2 D, II 2 D	-40 °C ... +85 °C	-40 °C ... +200 °C

The temperature class depending on the ambient temperature and the flange temperature is for the different versions as listed in following table:

Equipment category	Max. ambient temperature	Max. flange temperature	Temperature class
II 1 G	60 °C	60 °C	T6
II 1/2 G	60 °C	60 °C	T6
	75 °C	60 °C	T5
	85 °C	60 °C	T4
II 2 G	60 °C	60 °C	T6
	55 °C	80 °C	
	75 °C	75 °C	T5
	70 °C	95 °C	
	85 °C	85 °C	T4
	80 °C	110 °C	
	75 °C	135 °C	
	70 °C	150 °C	T3
	65 °C	180 °C	
	60 °C	200 °C	

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5 Examination Certificate - (Continued)

(13) **SCHEDULE**

(14) **to EC-Type Examination Certificate KEMA 07ATEX0068 X** Issue No. 1

The maximum surface temperature of the electronics enclosure "T", depending on the ambient temperature and the flange temperature, is as listed in following table:

Max. ambient temperature	Max. flange temperature	Surface temperature "T"
55 °C	80 °C	65 °C
70 °C	95 °C	80 °C
75 °C	135 °C	86 °C
60 °C	200 °C	90 °C

The enclosure provides a degree of protection of at least IP6X as per EN 60529.

Electrical data

Apparatus in type of protection intrinsic safety "i"

Supply and output circuit (terminals output 1, + and -):
in type of protection intrinsic safety EEx ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:
U_i = 30 V; I_i = 300 mA; P_i = 1W; C_i = 30 nF; L_i = 200 µH.

Supply and output circuit (terminals output 2, + and -):
in type of protection intrinsic safety EEx ia IIC, only for connection to a certified intrinsically safe circuit, with the following maximum values:
U_i = 30 V; I_i = 300 mA; P_i = 1W; C_i = 30 nF; L_i = 200 µH.

Apparatus in type of protection flameproof enclosure "d"

Power supply ..... max. 36 Vdc
Output ..... 4 - 20 mA
Intrinsically safe circuits ..... U_m = 253 V

Installation instructions

Apparatus in type of protection intrinsic safety "i"

When the Radar Level Instrument is used in explosive atmospheres caused by air/dust mixtures, cable entry devices shall be used that provide a degree of protection of at least IP 6X, which are suitable for the application and are correctly installed.

Apparatus in type of protection flameproof enclosure "d"

When used in a potentially explosive atmosphere, requiring the use of apparatus of equipment category 2G, flameproof certified cable entry devices shall be used that are suitable for the application and correctly installed. With the use of conduit, a suitable certified sealing device such as a stopping box with setting compound shall be provided immediately at the entrance to the flameproof enclosure.

When used in a potentially explosive atmosphere, requiring the use of apparatus of equipment category 2D, certified cable entry devices shall be used that provide a degree of protection of at least IP 6X, that are suitable for the application and are correctly installed.

Unused openings shall be closed with suitable certified blanking elements.

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5 Examination Certificate - (Continued)

(13) **SCHEDULE**

(14) **to EC-Type Examination Certificate KEMA 07ATEX0068 X** Issue No. 1

When the ambient temperature exceeds 70 °C, the cables, cable entry devices and sealing devices shall be suitable for at least 85 °C.

Routine tests

Routine tests according to Clause 16 of EN 50018 are not required since the type test has been made at a static pressure of four times the reference pressure.

(16) **Test Report**

KEMA No. 2104892/2

(17) **Special conditions for safe use**

Because the enclosure of the Radar Level Instrument is made of aluminium alloy, when used in a potentially explosive atmosphere requiring the use of apparatus of equipment category 1 G, the apparatus must be installed so, that even in the event of rare incidents, an ignition source due to impact or friction between the enclosure and iron/steel is excluded.

Also, see description and installation instructions above.

(18) **Essential Health and Safety Requirements**

Assured by compliance with the standards listed at (9).
Standards EN 61241-0 and IEC 61241-11 have been used as a guide.

(19) **Test documentation**

As listed in Test Report No. 2104892/2

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ORDER ACCEPTANCE: All Orders are subject to final approval and acceptance by Seller at its office located at 205 Keith Valley Road, Horsham, Pennsylvania 19044.

TERMS OF PAYMENT: Seller's standard terms of payment for Buyers who qualify for credit are net thirty (30) days from date of invoice. All invoices must be paid in United States dollars.

CREDIT: Seller reserves the right at any time to revoke any credit extended to Buyer or otherwise modify terms of payment if Buyer fails to pay for any shipments when due or if in Seller's opinion there is a material adverse change in Buyer's financial condition. Seller may, at its option, cancel any accepted Order if Buyer fails to pay any invoices when due.

DELIVERY: Shipments are F.O.B place of manufacture ("Shipping Point") and the Buyer shall pay all freight, transportation, shipping, duties, fees, handling, insurance, storage, demurrage, or similar charges from Shipping Point. Delivery of goods to common carrier shall constitute delivery and passing of title to the Buyer, and all risk of loss or damage in transit shall be borne by Buyer. Any claims or losses for damage or destruction after such delivery shall be the responsibility of Buyer.

Seller reserves the right to make delivery in installments which shall be separately invoiced and paid for when due, without regard to subsequent deliveries. Delay in delivery of any installment shall not relieve Buyer of its obligation to accept remaining deliveries.

Acknowledged shipping dates are approximate only and based on prompt receipt of all necessary information from Buyer and Buyer's compliance with terms of payment.

TAXES: All sales, excise and similar taxes which Seller may be required to pay or collect with respect to the goods and/or services covered by any Order, shall be for the account of the Buyer except as otherwise provided by law or unless specifically stated otherwise by Seller in writing.

TERMINATION AND HOLD ORDERS: No Order may be terminated by Buyer except upon written request by Buyer and approval by Seller, and if said request is approved by Seller, under the following conditions: (1) Buyer agrees to accept delivery of all of the units completed by Seller through the workday on which Seller receives the written termination request; (2) Buyer agrees to pay to Seller all direct costs and expenses applicable to the portion of the Order that is incomplete.

WARRANTY:

A. Hardware: Seller warrants its goods against defects in materials and workmanship under normal use and service for one (1) year from the date of invoice.

B. Software and Firmware: Unless otherwise specified, Seller warrants for a period of one (1) year from date of invoice that standard software or firmware, when used with Seller specified hardware, shall perform in accordance with Seller's published specifications. Seller makes no representation or warranty, expressed or implied, that the operation of the software or firmware shall be uninterrupted or error-free, or that functions contained therein shall meet or satisfy the Buyer's intended use or requirements.

C. Services: Seller warrants that services, including engineering and custom application, whether provided on a fixed cost or time and material basis, shall be performed in accordance with generally accepted industry practices.

D. Remedies: Seller's liability under this section is restricted to replacing, repairing, or issuing credit (at Seller's option) for any returned goods and only under the following conditions: (1) Seller must be promptly notified, in writing, as soon as possible after the defects have been noted by the Buyer, but not later than (1) year from date of invoice from Seller; (2) The defective goods are to be returned to the place of manufacture, shipping charges prepaid by the Buyer; (3) Seller's inspection shall disclose to its satisfaction that the goods were defective in materials or workmanship at the time of shipment; (4) Any warranty service (consisting of time, travel and expenses related to such services) performed other than at Seller's factory, shall be at Buyer's expense.

E. Repaired/Reconditioned Goods: As to out-of-warranty goods which Seller has repaired or reconditioned, Seller warrants for a period of sixty (60) days from date of its invoice only new components replaced in the most recent repair/reconditioning.

F. Returns and Adjustments: No goods may be returned unless authorized in advance by Seller and then only upon such conditions to which Seller may agree. Buyer must obtain an RMA (Return Material Authorization) number from Seller prior to any return shipment and such RMA number must appear on the shipping label and packing slip. Buyer shall be responsible for the returned goods until such time as Seller receives the same at its plant and for all charges for packing, inspection, shipping, transportation, or insurance associated with returned goods. In the event that credit for returned goods is granted, it shall be at the lesser of the then current prices or the original purchase price. Claims for shortage or incorrect material must be made within five (5) days after receipt of shipment.

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Seller shall defend any lawsuit brought against the Buyer based on a claim that the design or construction of the goods sold hereunder by Seller infringe any United States or Canadian Patent, Copyright or Mask Work Registration, provided that Buyer promptly notifies Seller of such claim in writing and further provided that, at Seller's expense, (1) Buyer gives Seller the sole right to defend or control the defense of the suit or proceeding, including settlement, and (2) Buyer provides all necessary information and assistance for that defense. In the event of a charge of infringement, Seller's obligation under the agreement shall be fulfilled if Seller, at its option and expense, either (i) settles such claim; (ii) procures for Buyer the right to continue using such goods; (iii) replaces or modifies goods to avoid infringement; or (iv) accepts the return of any infringing goods and refunds their purchase price; or (iv) defends against such claim.

If Buyer furnishes specifications or designs to Seller, the obligations of Seller set forth above shall not apply to goods made by Seller using such specifications or designs, and Buyer shall defend, indemnify and hold Seller harmless against any third party claims for infringement which arise out of Seller's use of specifications or designs furnished by Buyer.

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PACKAGING/WEIGHTS AND DIMENSIONS: Buyer specified packing or marking may be subject to additional charges not otherwise included in the price of the goods. Published weights and dimensions are estimates or approximate only and are not warranted.

FORCE MAJEURE: Seller shall not be responsible for delays in delivery or any failure to deliver due to causes beyond Seller's control, including but not limited to the following items: acts of God, war, terrorism, mobilization, civil commotion, riots, embargoes, domestic or foreign governmental regulations or orders, governmental priorities, port congestion, acts of the Buyer, its agents or employees, fires, floods, strikes, lockouts and other labor difficulties, shortages of or inability to obtain shipping space or transportation, inability to secure fuel, supplies or power at current prices or on account of shortages thereof, or due to limitations imposed by the extent of availability of Seller's normal manufacturing facilities.

If a delay excused per the above extends for more than ninety (90) days and the parties have not agreed upon a revised basis for continuing providing the goods or services at the end of the delay, including adjustment of the price, then Buyer, upon thirty (30) days' prior written notice to Seller may terminate the Order with respect to the unexecuted portion of the goods or services, whereupon Buyer shall promptly pay Seller its reasonable termination charges upon submission of Seller's invoices thereof.

LIMITATION OF LIABILITY: Seller's liability for any claim of any kind, except infringement of intellectual property rights, shall not exceed the purchase price of any goods or services which give rise to the claim. ***SELLER SHALL IN NO EVENT BE LIABLE FOR BUYER'S MANUFACTURING COSTS, LOST PROFITS, LOSS OF USE OF THE GOODS OR SERVICES, COST OF CAPITAL, COST OF SUBSTITUTE GOODS, FACILITIES, SERVICES OR REPLACEMENT POWER, DOWNTIME COSTS, CLAIMS OF BUYER'S CUSTOMERS FOR DAMAGES, OR OTHER SPECIAL, PROXIMATE, INCIDENTAL, INDIRECT, EXEMPLARY OR CONSEQUENTIAL DAMAGES.*** Any action against Seller must be brought within eighteen (18) months after the cause of action accrues. These disclaimers and limitations of liability shall apply regardless of the form of action, whether in contract, tort or otherwise, and further shall extend to the benefit of Seller's vendors, appointed distributors and other authorized resellers as third-party beneficiaries.

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GOVERNING LAW: Seller intends to comply with all laws applicable to its performance under any order. All matters relating to interpretation and effect of these terms and any authorized changes, modifications or amendments thereto shall be governed by the laws of the Commonwealth of Pennsylvania. No government contract regulations or clauses shall apply to the goods or services, this agreement, or act to bind Seller unless specifically agreed to by Seller in writing.

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